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Second Order Science and Policy

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Abstract

In March 2016 an interdisciplinary group met for two days and two evenings to explore the implications for policy making of second order science. The event was sponsored by SITRA, the Finnish Parliament's Innovation Fund. Their interest arose from their concern that the well-established ways, including evidence based approaches, of policy and decision making used in government were increasingly falling short of the complexity, uncertainty and urgency of needed decision making. There was no assumption that second order science or second-order cybernetics would reveal any practical possibilities at this early stage of enquiry. On the other hand some members of the group are practioners in both policy and in facilitating change in sectors of society. Thus the intellectual concepts were strongly grounded in experience. This is an account of the deliberations of that group and some reflections on what came out of the various shared contributions and ensuing dialogues. The overall conclusion of the event is that there definitely are possibilities that are worthy of further research and exploration.

KEYWORDS: second-order science, second order cybernetics, policy, complexity, transformation, evidence, uncertainty, practice, transdisciplinarity

Introduction

The purpose of the forum and this subsequent report was to explore the potential relevance of the emerging field of second-order science to policy practice. An underlying reason behind this is the view that there is a 'complexity gap' opening up between the customary ways of using evidence based policy and the actual complex behaviour of the world. This is essentially a future oriented exercise since the field of second-order science as a formulated discipline is only recently emerging as is a more fundamental questioning of policy practice and the search for new ways.[1]

This report is a contribution to creating effective policy practice for a complex world. It is a first iteration of what needs to be a continuous learning and discovery process.

The process for carrying out this exploration was a form of open dialogue forum that has been used and developed by the IFF over the last fifteen years.[2] Its characteristics are that is interactive, transdisciplinary and opens up questions rather than presents answers. It is also a process that needs expert facilitation.

A group of sixteen people from very different fields that shared a common interest in the topic was convened for two full days, including two evening dinner conversations. The policy area was represented by Kaisa Lähteenmäki-Smith from the Finnish Government, Richard Sanford of UK Government Foresight, Timo Hämäläinen from Finland's SITRA, Nigel Topping who was deeply involved in the COP21 Paris conference and Stephen Olsen, experienced in the regulation of complex human-ecological systems. Different aspects of

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change initiative in complex situations were represented including education, agriculture, coastal management, health and economic development.

Second-order science was introduced to the group by the world leading expert, Dr. Karl Müller from Vienna. A central notion of second-order science, not present in first order science, is the legitimate presence of the observer, the acknowledged social context of any science and the role of a specific language that links these in a three-way relationship. He was supported with three additional distinctive perspectives from Professor Gerald Midgley, Dr. Tom Flanagan and Dr Daniel Wahl.

As the domains of second-order science and policy practice interacted in the first stage of the forum, three challenging themes emerged as the basis for deeper dialogue; the significant features of second-order science potentially relevant for policy; the context of evidence-informed policy and its limitations; responding effectively to the challenge of uncertainty. The three themes were interwoven by a series of remixing of the membership of the three groups followed by a plenary review of all three outputs. Further reflection on this material has identified seven basic characteristics of second-order science that are also present in policy practice and provide insights for linking the two in a way that enhances policies for complex situations.

However, this result of the forum needs to be interpreted as a first iteration of a process, itself second-order, that needs to be further developed by theoretical and practical research linked to projects of action learning in a variety of policy fields. To carry this out needs a continuing transdisciplinary forum and engagement with policy issues that have not yielded very well to first-order approaches. This report recommends such a programme.

The Context of the Forum

The historical evolution of civilizations has been characterized by growing specialization and division of physical and intellectual labour. Every now and then, this evolution has been interrupted by a governance crisis when the established organizational and institutional arrangements have become insufficient in dealing with the ever-increasing complexity of human interactions. Some commentators use the term “complexity gap” for this situation.[3] Today’s societies are, again, experiencing a complexity gap. There are serious governance problems at all levels of our societies: individuals suffer from growing life management problems, corporations struggle to adapt with their rigid hierarchies, governments run from one crisis to another, and multinational institutions make very little progress in solving global problems. A transition to the next phase of societal development requires closing the complexity gap with new governance innovations. Or else societies may face disintegration and chaos.

The complexity gap is not limited to governance arrangements. The growing specialization of scientific disciplines and the rapid transformation of societies have created a ‘knowledge gap’ between the ever more complex and uncertain world and the narrowly-specialized scientific knowledge about it. This knowledge gap raises a fundamental question: How well can we understand a world that consists of numerous highly complex and uncertain systems with reductionist science that focuses on particular phenomena and neglects their interdependencies with other parts of the system? This is the question that led Sitra to the theme of Second Order Science (SOS) which takes the complexity of the world as its starting point.

In the SOS, the researcher is never only a detached and neutral observer of the system under study. She is a participant in the system whose subjective choices and assumptions influence the research results which, in turn, shape the system in one way or another. This kind of social constructivism is already common in many parts of social sciences but it is rarely discussed in natural sciences. Moreover, the limited individual and disciplinary cognitive frames tend to narrow the researcher's focus on certain issues and perspectives while excluding others. The established scientific infrastructures further constrain the scope of her inquiry. These cognitive and physical limits result in partial views of the complex reality.

Besides an observer, the researcher is also an actor and decision maker who intervenes in the system by introducing and promoting certain ideas. She has an impact on the system. For example, influential economists shape policy making with their theories and statements. This underlines the importance of the researcher's values and ethics. Science and knowledge are not value-neutral.

The growing specialization and differentiation of phenomena emphasizes their uniqueness. The dominance of quantitative analysis, statistical averages and the assumptions of normal distribution become problematic in highly specialized and complex systems. Unique phenomena and contexts call for qualitative research that is sensitive to contextual differences as well as local and practical knowledge. Successful approaches cannot be simply scaled to other contexts because these contexts differ. They can only be 'spread' and adapted to new contexts.

The SOS overcomes the problem of reductionism by integrating multiple different perspectives and types of knowledge in understanding a phenomenon. This requires multi-stakeholder dialogues that can achieve transdisciplinary syntheses. Organizing and facilitating such dialogues is a key challenge for policy making in the future. In an increasingly complex and uncertain world, policy making has to become a continuous, experimental and collective learning process.

After long history of specialization and differentiation, the traditional discipline-bound science needs to be complemented by a more holistic and integrating approach to knowledge creation - Second Order Science.

Why discuss second-order science and policy?

The Challenge of Complexity

Today's challenges to policy and governance are globally enmeshed in multiple complex networks and systems. The result is that we have shifted from the complicated world to a complex world which has less predictable properties such as acceleration, emergence and discontinuity. This new pattern profoundly challenges the adaptive capacity of our legacy systems of government, which are modelled on hierarchy, segmentation, and fragmentation into silos.

One major approach to dealing with the complexity is to improve understanding of context by introducing more science-based research, data and evidence to inform policy. This is certainly an improvement on purely speculative policy which has not been grounded in pertinent information and interpretation. But it also depends heavily on the dominant science paradigm of determinism which is well-suited to the complicated world but increasingly fails in the complex world. It fails to take into account uncertainty, value loading, and a plurality of legitimate judgemental perspectives.

These latter factors clearly influence the current reality of policy development even in those areas which claim a strong evidence base[4]. In his paper *How Policy is Really Made* Edward Page[5] points out that: "Policy has a life of its own and is dependent on something resembling chance – who happens to be at a meeting, whose star is in the ascendant and suchlike".

If unintegrated into a coherent worldview, evidence informed policy also has limitations. The implicit assumption of a linear relation between research evidence and policy needs to be replaced with a more interactive model that relates to the role of human judgement in crafting and balancing policies. This interaction is essentially between the objective data and the subjective appreciation of human beings. As Geoffrey Vickers pointed out 'human systems are different'.[6]

A take-off point for this Forum was the proposition that effective policy making for today's world needs more than the use of more and better scientific evidence to improve its effectiveness. Knowledge is not the only aspect required for effective action. For example, ethics and aesthetics have a role and some view of the future is involved. Evidence from the future is not part of normal science. Without a clear understanding of the relationship between objective science and subjective human judgement a contradiction remains between evidence base and practical policy making. This contradiction tends to become locked into institutional cultures, practices and expectations even to the point of becoming undiscussable, partly because policy is also about power and hidden agendas. So we can pose the question: is rational decision making in practice underpinned with factors, negative and positive, which although they cannot be reduced to rationality can never-the-less be treated in a scientific manner? [7]

If so, this will require a new model of science. There are a number of emerging searches for new models of science better suited to the world of complexity and which can accommodate human agency as a legitimate component. Such approaches contrast with the primary orthodoxy of reductionist science well summarised by von Foerster[8] as "In no way shall the observer enter into the observation". Hence this Forum explored the nature of 'second-order science' in which the role of the observer/decider is included rather than excluded from the science. This development is emerging in parallel from a number of fields including second order cybernetics[9], the science of qualities[10], third phase science[11] and the nature of anticipation[12]. This is a science in which the observer is included, pattern may be as significant as natural law, interdisciplinarity is essential and rare and extreme events can be highly significant.

For similar reasons there are also parallel thoughts emerging about how to frame and construct policy for effectiveness in the new landscape of complexity. One example is the approach *policy as learning*[13] in which policy is viewed more as a learning process than a problem solving process. In a complex world the ground is always shifting with emergence and unintended consequences. But the conditions for learning in policy circles are inhibited by governmental institutional cultures, and by failure of the universities that educate them, to provide skilling up in collaborative learning.

Another example is where the complexity is at a global level. Climate change and carbon pricing have recently been approached in a quite new way where the starting point is the identification of dilemmas that need to be *navigated along pathways* rather than fixed by solutions. This requires a process of starting new conversations amongst multiple stakeholders about complexity based on fundamental dilemmas. The evidence produced by reductionist science in particular disciplines is often insufficient for (re)solving wicked policy problems.

Structuring the Dialogue

The aim of the Forum was to accelerate a cross-fertilisation of the two domains of second-order science and policy; and to do this by bringing a variety of viewpoints on science and also on policy together into a generative dialogue. In effect the Forum explored the boundary between first-order science (observer excluded) and second-order science (observer included) and the boundary between evidence informed policy and policy as human learning; all this in the context of the shift from a complicated world to a complex world as the main context (see Figure 1).

Figure 1 – The overlapping themes of the forum

The Forum began with a series of short presentations exploring the new context of ***complexity*** and the challenges it brings, and the new models of ***science*** and of ***policy*** that are emerging to meet those challenges.

A number of emerging new models of science better suited to the world of complexity and to accommodating human agency were considered. Four of these new models and their perspectives were explored in the forum: second-order science; third phase science; systemic intervention, and a science of qualities. These are summarised under the heading *The World of Second-Order Science.*

New approaches to understanding the context of and the practice of policy development are also emerging. Clarity about these helps to show up the boundaries of conventional science as it relates to the real challenges on the ground, whether that be on any scale from local to global. Four perspectives were explored, all linked by the common theme of complexity as conditions which no longer yield to the paradigm of dissection and re-assembly. These were the complexity challenge to governance; policy as experimentation at national level; processes for consensus at the global level, and the urgent need for effective transdisciplinary approaches. These are summarised as *The World of Complexity.*

A third perspective was based on a sample of situations where efforts at transformation are being pursued to deal with the challenges of complexity. These represent illustrative arenas in which the possibilities of second-order science and policy evolution might be both relevant and tested. The four illustrations were responding to challenges in coastal communities in Africa; a holistic approach to regenerating sustainable agriculture; the challenges of retaining humanised health care in the face of techno-medicalisation, and the innovation of approaches to present education that develop competences for complex unknown futures. These are summarised as *The World of Transformation.*

These three clusters of presentations were taken as a starting point for the dialogue that followed, which itself was structured as follows:

- What questions do the various presentations provoke?
- How do these questions cluster into themes?
- Which three themes are most interesting to pursue in depth?

This process generated the following three themes for dialogue:

1. **The significant features of second-order science**
2. **The context of evidence-informed policy**

3. The challenge of uncertainty

These three parallel dialogues (with interchanges of people) have been distilled in the report that follows in three sections:

- The question cluster: what questions raised by the initial presentations went into the formation of this theme
- The distillation of the conversation: a summary of the discussion, largely based on the plenary feedback from participants
- The salient points emerging: both as discussed in the group and reflecting further comments in the plenary session.

Throughout these sessions extensive use was made of ‘doodle boards’ which enables everyone to express their ideas and build up a picture of the conversation.

The Context of Second-order Science

The readers ready to explore the generative dialogues between ideas and perspectives that follow will inevitably find a question forming in their mind at almost every turn. It is this: “what, precisely, do the authors mean by ‘second-order science’”?

This is a very good question, but one without a simple answer. A good part of the initial framing content for the dialogue consisted of different perspectives on that very question. Second-order science is itself an emerging field of inquiry with its own niches, advocates, specialists and so on.

The first four presentations in the Forum explicitly explored different views of what makes for second-order science. Much of the first dialogue (page 30) explored these questions of what is second-order science, how does it differ from first-order science, and what does one do to practice as a second order scientist?

These questions are more likely to confuse than to clarify the thoughts of a reader seeking some anchor points for the discursive pages that follow. In a way that feeling would mirror the experience of the participants in the dialogue – who were finding their way in these conversations holding on to fragments of definition and/or strongly held convictions in the face of other perspectives and emerging insights. At the same time, the Forum sought to bring these perspectives into the dialogue in the search for those elements that might benefit from further exploration and research in the context of improving policy-making in conditions of complexity.

Notions of second-order science and of Science 2.0 or Science II will be found in the literature. The forum members were concerned to unearth some of the basic principles of second-order science, recognising that it is still an evolving field and that the surrounding terminology can be confusing. The group were concerned to clarify some basic concepts and principles that would help shape the dialogue in orientation to policy implications. This central concern in effect gave some shape to the dialogue overall and helped to unfold the notion of second-order science in certain directions *in the context of this dialogue* over the course of the two days. That evolution is briefly summarised below to help the reader make the transition from the series of talks, through the dialogue, to the reflective summary.

Science 2.0: [14] Science pursued within the technologies and social processes of Web 2.0.

- Important for science policy but not necessarily different from science conducted in other ways and not second order in any obvious sense.

Science applied to itself: tests of tests, systems of systems, models of models etc.

- This is clearly second-order and reflexive. As a means of exploring new scientific horizons this is a generative tool for horizon scanning, but is not necessarily new as regards foundations. Theorists and philosophers of science are always testing and disrupting the foundations and finding new and deeper convergence between disparate fields.

Second Order Cybernetics: "the observer is part of the system"

- This points to the essential shift of second order science as the recognition that there is no such thing as a God's eye view of reality, and that all science is a form of intersubjective reality.

Science and technology as social processes:

- We face a paradox in the governance of science: we pursue science as an intentional societal process, and yet over the long term we have very little control over what social effects the curiosity driven process of enquiry will have as it gives rise to new technological powers. Becoming more aware of who funds what and why – the call for more participation and precaution, and the examination of societal assumptions and norms – is the usual response, and helps us guide our way forward as possibilities arise (e.g. in human genetics). This response is important, but not new.
- The inquiry into second-order science is an attempt to find some new theoretical foundations that would go some way to resolving the paradox at a more fundamental level.

The irreducible nature of first person experience:

- First person conscious experience is an irreducible reality. We have no idea what it would mean for it to 'emerge' from the material reality that is the assumed foundation of first order science. In accepting this we can make the move to recognise that all knowledge is a form of intersubjective coordination of our first person experiences of the world.
- This supports the next meaning.

Observation = Intervention: we are world makers:

- At the level of quantum phenomena we have discovered that how we observe the world changes how it turns up;
- At a biological level the enactive account establishes the idea that the dynamics of life create a perspective on the world, and 'bring forth a world'; thus in this sense the system of which an organism is a part can only be understood by understanding that life is a cognitive process of sense-making – each life is the origin of a perspective of meaning in the world; as such observation (cognition) = intervention (living).
- At a psychological level, "for the moment what we attend to is reality" (William James)
- At a social level, as we choose the boundaries of a system of concern we simultaneously establish the terms in which it will be examined and understood, and hence how we might seek to change it. The process of observation therefore brings into view a partial reality that sets the terms of engagement – what facets

will be seen as salient, and what other points of view of and within the system will be granted validity.

- Thus, in stepping into second order awareness of science we become aware in our first person experience that we are taking up a specific form of mental stance to create intersubjective reality of objects – moving from a third person assumed reality to a second person shared form of attention.
- From this step we can make the final move.

The Methodological turn of Second-Order Science:

- There is a danger that we will attempt to understand second order science in first order scientific terms, and succeed only in making our confusion worse, and deepen our subjugation to an inappropriate deterministic and materialistic realism.
- The shift to second order science needs to be a methodological one to recognising the validity of first person experience as the context for all science, and that this is primarily a shift to self-awareness of our own engagement with scientific knowledge – a shift to meta-cognition.
- This then allows the shift from science as 'the' truth, to science as 'a' truth, alongside others; not to replace science with opinion, but to practice second-order science as first-order science held within the context of first-order lived experience.
- Second-order science is therefore a form of awareness practice, with a methodology that must be cultivated and shared like any other to become a social practice, and has no meaning without it.

The above notes, distilled from the conversations, are to be read not as a conclusion but as an introduction to what follows. Readers will bring their own experience – and their own appreciation of 'science' in all its many forms – to the task of teasing the sense from these conversations and in particular identifying what is new and potentially useful from what is familiar (even if expressed in novel language) and already in play in policy circles. The aim of the Forum was to open up the territory and to find the most potentially productive learning edge in the dialogue between science and policy.

This leads us to the introductory talks.

The Introductory Talks

As the diagram of overlapping themes (Figure 1) shows, the forum aimed to bring together diverse perspectives. It needed to be transdisciplinary. Further, it was clear that taking the theme of second-order in a broad way opened up the possibility of finding common ground between different approaches to 'beyond first-order science' that are not in the same domains of the research literature. If that were not complexity enough, the field of policy is vast and diverse, so some way of sweeping in enough representative diversity was needed. Finally, as always with such ventures, there were limitations of resources, time and availability of people. Another requirement of a forum is that its nature is to be dialogic; that is to say stimulating exploratory conversations rather than presentation of papers on finalised work. This placed a demand on invited participants to:

a) Participate in the spirit of enquiry, tolerance of ambiguity and mutual exchange;
b) Contribute their essential perspectives succinctly as thought starters for the conversations;
c) Build on each other's ideas without expecting immediate conclusions.

The forum was fortunate in that such a group of people from diverse backgrounds came together in that spirit.

To set the dialogues in motion there needed to be a starting phase of people becoming sufficiently familiar with each other's thinking, perspectives and specific language and terminology. This was accomplished through setting up twelve talks of not more than fifteen minutes each in which each speaker placed their 'food for thought' on the table. The talks were divided in three groups of four, each with an overarching theme. The three themes and their rationale were:

1) **The World of Second Order Science**
   The first group of four speakers each took a different perspective on what distinguishes a form of science as second-order. The four perspectives were deliberately chosen to be from a different domain in which aspects of second-order thinking and method are emerging. These were new cybernetics, third phase science, systemic intervention and the science of qualities.

2) **The Complex World of Policy**
   Increasing complexity is one of the drivers for taking an interest in the theme of the forum and so the second group of speakers each shared a different view of the challenges of governance. These range from national to global.

3) **The World of Transformation**
   The third group introduced different social contexts in which needs, evidence and policy all interact in the effort to bring about some transformation to a better state of affairs. They include agriculture, environment, health and education.

After each group of talks, participants reviewed what they had heard and logged questions arising. The discussion was limited to matters of clarification. Well over seventy questions were generated and these were clustered as a preliminary to identifying three distinct themes for parallel dialogues to follow. The intention behind the construction of the themes was to create an arena for dialogic exploration of the primary question of the forum.

The reader is invited to read each synopsis in the mood of seeing how they might incorporate it into their own thinking about the primary question. Some of the material may be unfamiliar and, in such a brief summary, not immediately make sense. One of the roles of the dialogue which followed was to pursue that sense making.

The name of the contributor of a given talk is given and their brief background is given in the Appendix 'Members of the Forum'.

THE WORLD OF SECOND ORDER SCIENCE

1 What makes science second order?[15]

Karl Müller

To begin to answer this question we need to take a quick overview of developments since the middle of the last century. In the literature, Science II refers to the increasing prevalence of complexity. Science 2.0 is used more to refer to new web-based forms of scientific cooperation and interaction, including citizen science. Also emerging in the 1950s in parallel with cybernetics is the system science of second order cybernetics. So in moving to the term 'second-order science' what can it be?

Heinz von Foerster (1911-2002),[16] the father of second order cybernetics, talked of a Copernican revolution in science and planted a seed which has produced two types of fruits: new reflexive scientific domains and new reflexive epistemic modes. If we consider first-order science to be exploring the world, then the science of reflecting on these explorations and the revolution in reflexivity constitute second-order science.

There are two dimensions of reflexivity: firstly a new epistemic mode of exploring the world and secondly a differentiation of the science into three levels. These levels are:

- Zero-order science: research infrastructures fully in operation across major science domains and which perform a catalytic function for first-order science. For example the CERN accelerator and the Hubble telescope.
- First-order science: exploring the world in the manner of science as we know it.
- Second-order science: operating on elements from first-order science and providing the reflexive function for first-order science.

The two epistemic modes can be described as Exo-science and Endo-science. Exo-science is the dominant mode of first-order science in which the researchers are eliminated from the results of research processes. Endo-science is inclusive of the researcher and is recursively closed. In summary, exo-science is science from without and endo-science is science from within.[17]

The implication is that second-order problems can be generated for all types of elements from first-order science on different levels of scope and scale. A key concept in this aspect of second-order is the notion of re-entry, the logic of which was originated by Spencer Brown. The classical symbol for this is the uroboros, the serpent that eats its own tail. Von Foerster introduced this as the 'cybernetics of cybernetics'. For example:

- Theoretical Concepts (quality of life of quality of life etc.)
- Models (models of models, etc.)
- Theories (evolution of evolution, etc.)
- Tests (test of tests, etc.)
- Patterns (patterns of patterns, etc.)
- Systems (systems of systems, etc.)
- Surveys (survey-studies of survey studies, etc.)
- Distributions (distributions of distributions, etc.)

We can summarise with a very brief overview of four ways of operating in a given science field. In the chart below we show that first-order science can operate in the Exo mode and the Endo mode. Similarly second-order science can also function in the Exo and the Endo mode. For any discipline or field four modes are possible:

	Exo-Mode	Endo-Mode
Second-Order	Exo Second-Order Science	Endo Second-Order Science
First Order	Exo First-Order Science	Endo First-Order Science

The distinction of second-order from first order is further deepened by recognising it is a triadic structure (Figure 2). It is constructed from three components which need to be copresent and interrelated. These are (a) a human observing system (b) a specific language (implying a shared codification of meaning) and (c) a social context. To quote Heinz von Foerster:

Figure 2 – The triadic structure of second-order

“Let me repeat the three concepts that are in triadic relation connected to each other. They are: first, the observers; second the language they use; and third, the society they form by the use of their language. This interrelationship can be compared, perhaps, with the relationship between the chicken, and the egg, and the rooster. You cannot say who was first and you cannot say who was last. You need all three in order to have all three.”[18]

2 Third phase science and dialogue[19]

Tom Flanagan

There are at least three modes of making sense from an observation of a strange or novel situation. These are the three phases of science shown in the graphic below.

One mode is observer independent, and the object remains a constant. A second mode is observer dependent, and the object may respond to the process of observation. A third mode is pluralistic, and whether the object itself does or does not change as a result of observation is secondary to the fact that the object is augmented with understandings which are projected on to the view of the object by the parallel observers.(Figure 3)

Figure 3 – Three phases of science

None of these "phases of science" are really new, and their application to science (as a continually self-improving lens for looking at objects in a certain way) is present in one situation or another.

In 1^{st} Phase the observer is excluded from the observation. In 2^{nd} Phase the observing system includes the observer and the object. In the 3^{rd} Phase there are multiple observers perspectives that characterise the (still incomplete) nature of the object.

If one reflects on the way that one views objects, then one can change the shape of the lens (the science) through which the object is seen. This is consistent with the notion of the reflective practitioner.

We are all victims of the individual frameworks that we use as lenses to look on the world. Only when we engage each other in dialogue might we discover reasons to look more deeply at our choice of the governing framework for extracting meaning from the observation. What we discover with third phase science is not primarily about the nature of objects but rather about the nature of our way of observing the objects. We have a reflective tool for refining our choice of and our use of observational lenses. Regardless of where we sit around a complex problem the framework that we will first seize to examine the problem will be the framework that we are biased to seize. Whether with the benefit of virtue or the burden of vice, our choices are not really a matter of *deliberative* choice. Whether we are trained in physical science, social science, philosophy or art, we will have preferred frameworks. This means that even as we seek to be objective, our very first glance upon a problem object will betray our subjectivity.

We could model the influence of reflection (or peer influence) in challenging the way we see the world. This is more than peers sharing their personal perspectives on other ways to see the world. The influence is upon the lens of an individual's observation in all three phases of sense making or meaning making (i.e. science) and would be an input upon the lens itself. This is a circularity of influence which represents an expansion of John Warfield's Domain of Science Model. The larger question then becomes who or what resource and influence polishes or distorts the lens of an individual's science, and how is this intervention informed explicitly in its community mission?

In this viewpoint we are acting with a form of re-entry: thinking about thinking; observing observation; making sense of sense making. Our question is "*what is the vantage point for such activity?"* Can this vantage point be sustained reliably in an institution or in a philosophical ethos for self-reflection or does it require something else entirely? The definitive third phase science methodology[20] for assuring the emergence of a coherent consensus for a model of the problem based on observations made within complex situations is Alexander Christakis's structured dialogic design.

3 Systemic intervention as second-order systems science[21]

Gerald Midgley

The term second-order originated in the field of cybernetics. Second-order cybernetics was particularly formulated originally by von Foerster in a conference talk 'the cybernetics of cybernetics'. Systemic intervention (SI) has key assumptions that are congruent with second-order assumptions but differ in some respects from second-order cybernetics.

First-order cybernetics concerns observed systems, relates to the purposes of the system being modelled and models the interaction between variables in a system. Second-order cybernetics concerns observing systems, addresses the purposes of the model of the system, and considers the interaction between the observer and the observed.

The core modality of SI is intervention, defined as purposeful action to bring about improvement. It proposes that, actually, we are incapable of non-intervention and that observation is just one kind of intervention activity.

The key assumptions of systemic intervention:

- Everything in the universe is directly or indirectly connected to everything else
- However, we cannot have a 'god's eye' (comprehensive) view of this interconnectedness
- Our perspectives are always *partial*, in two senses
  - limited
  - informed by our purposes and values
- This partiality can be represented as a *boundary*
- Paradoxically, we can achieve a *greater* comprehensiveness by acknowledging the *impossibility* of comprehensiveness, and exploring *different (and emerging) options* for boundary and value judgements to inform enquiry

The key assumptions of systemic intervention are summarised above. A visual representation of the importance of boundary and value is represented in the next diagram. An essential concept in systemic intervention is boundary critique which aims through shared reflection to reveal assumptions behind the definition of the system. The vertical axis in the diagram is the ethical dimension determined by the stakeholder's values which is a central distinction of the system. This dimension profoundly affects what is considered to be the boundary of the system which determines who and what is included or excluded from the system. This is a second-order operation distinct from applying first-order systems methods.

Figure 4 – A visual representation of the basic relationship between boundaries and values

The distinctions between first-order science and second-order science from the perspective of SI are summarised in the table in Figure 3.3. Intervention is contrasted with observation; methodology is related to purposes and values that inform the intervention; inquiry includes rightness understanding and improvement in addition to truth; the consideration of values means that the exploration of what to research is included; and the dialogue that leads to this is important.

Proposed distinctions between first and second order science, informed by systemic intervention	
1st Order Science	2nd Order Science
The key modality is observation	The key modality is intervention
Methodology aims to construct independent observations	Methodology aims to situate observations in relation to reflections on purposes and values to inform intervention
One ideal of inquiry: *truth*	Four ideals of inquiry: *truth*, *rightness* and *subjective understanding*, all contributing to an emergent view on *improvement*.
Values inform what is observed, but are taken as given, not open to inquiry	Values are an important focus of inquiry because of the need to explore what to research, not take the given remit for granted
The exploration of what to research, and from whose perspective, is divorced from the research itself	The exploration of what to research, and from whose perspective (including the construction of new perspectives through dialogue) is integral to the research

The outcome, which has implications for policies, is four key challenges:

- for scientists to rethink science as intervention by a community of scientists;
- for scientists to view the construction of a research project as part of the research;
- for science funders to include stakeholder dialogue processes on what ought to be done in policy and practice with the research questions; and
- for those others working in the field to understand that the development of second-order science is itself an intervention.

4 Towards a science of qualities[22]

Daniel Wahl

Another line of work to consider in relation to second-order science is the development of a science of qualities. One exponent of this approach is Brian Goodwin[23] who researched complexity in the context of the biological sciences and who came to the conclusion that first-order approaches like biochemistry and genetics have severe limitations. This led him to propose a participatory science of qualities which shifts from aiming for prediction and control to moving into appropriate participation in unpredictable, complex dynamic systems.

Parallel to this work and connected with it is Henri Bortoft's work on the phenomenology of perception in science. Bortoft[24] distinguishes between real and counterfeit wholes. He points out that most of our attempts at holistic thinking ends up treating the whole as another kind of part. The result is that we have deconstructed the subject of interest before we have even carried out our inquiry into it. Only if we become sensitive to the coming into being of the phenomena can we come to a fuller understanding of their qualitative as well as their qualitative aspects. He showed how this was essentially the method of Goethean Science.[25]

However, we have a strong legacy in Western science taking us back to Galileo's distinction between primary and secondary qualities. We try to quantify qualities through measurable indicators which abstract from and cut us off from appreciating distinctive qualities. In addition to measurement we also need participation. In fact we do this but it is obscured by the dominant emphasis in first-order science placed on objectivity. Popular opinion still understands science as a means to create an "objective" representation of reality. From the perspective of qualitative science all methodology is a form of inter-subjective consensus making.

Another approach to this is the Santiago theory of cognition which seeks to overcome the Cartesian split that predisposes us to a quantity and object-focussed ways of seeing. Maturana and Varela[26] pointed out that our perception is a two way street between ourselves as observer and our environment as reciprocating our perception. This structural coupling implies that whatever we are investigating is a world we have brought forth through the acts of our inquiry.

The shift to a different mode of science and the need to deepen our understanding of the world at large has huge relevance to our contemporary economic system and the necessity to shift from quantitative growth to qualitative growth. Humans and human society are biological systems and need to emulate nature as they mature, shifting from continuous exponential growth to S-curve growth that operates within limits. There is a need for the evidence from first-order science to be complemented by second-order observation to make explicit the 'mode of investigation' and the 'way of seeing' which underlie any policy recommendation. This requires us to define a shared methodology and perspective as a basis for replicable experiments and intersubjective consensus making between scientists, policy makers and citizens.

A science of qualities leaves room for the role of ethics and the consideration of undecidable questions which cannot be reduced to rational logic. It brings to the surface the presupposition in first-order science that it is observer free and ethically neutral. A science of qualities enables a values-led rather than a supposedly "values free science". This has massive implications for the future including what kind of technology we will invent. Will we disappear in a technological singularity or will we evolve rapidly to be a wise keystone species practising anticipation to create regenerative and resilient life-support systems congruent with the actual bio-planet on which we live?

THE COMPLEX WORLD OF POLICY

5 Complexity beyond governance[27]

Timo Hämäläinen

Policy and governance are increasingly challenged by the *complexity gap*: the mismatch between the established institutions and policies that run our societies and the increased complexity and uncertainty of the real world. This gap is being widened by historical transformation; by globalisation and growing specialisation; by increasing population and mobility; and by new communication technologies. It is exacerbated by systemic inertia and institutional rigidities.

Continuing to tackle complex social problems with traditional means is counter-productive and tends to lock us into the very rigidities we need to dissolve. The Ashby space from Cybernetics[28] offers a useful framework for seeking solutions to this governance problem.

Figure 5 – How to deal with complexity and uncertainty – the Ashby space

This concept is illustrated in the diagram above in which the vertical axis represents the complexity of the problem and the horizontal axis represents the variety of the available policy responses. There are two principal strategies for dealing with complex problems. The first (efficiency) strategy is to try to reduce the complexity of the system (the move from A to B). The other strategy creates requisite variety by increasing the diversity or variety of responses (the move from A to C). This increases the degrees of freedom and adaptability of the governance arrangement. However, this strategy is expensive and may face budget constraints. If one pushes the first strategy too far there is a risk of over-simplification; if one pursues the second strategy too far there is a risk of over-complexification and resource depletion.

A viable system can be created by balancing these two strategies over a restricted bandwidth between efficiency and diversity. This is represented in the diagram below as the window of viability at the top of the curve. Too much efficiency leads to brittleness and too much diversity can lead to stagnation.

Figure 6 – Efficiency vs. Diversity – a sensitive balance

In a more complex and uncertain environment, however, the window of viability at the top of the curve needs to shift towards greater diversity in order to deal with the complexity gap. Hence the new balance involves more diversity and interconnectivity and reduced efficiency, as shown in the diagram below. In this new state, the governance arrangements must increasingly rely on distributed bottom-up policy development as contrasted with the currently dominant centralised top-down approach.

Figure 7 – Efficiency vs. Diversity – a new balance

Complexity absorption strategies need to increase diversity, decentralisation and scope for individual choices. They also need to provide for experimentation, foresight and open- innovation. The scientific knowledge needs to integrate both tacit and contextual content produced increasingly by collaboration, networking and co-production. Civil society must participate in public decision making and be included through improved communication and dialogue. Effective change occurs through hybrid organisations that can work across sectors and silos with shared visions, simple rules and transparency. Representative democracy needs to be complemented with direct democracy which supports evolutionary policy-making (variation, selection and diffusion). Education for this approach is challenging and requires much more student-centred approaches, cross disciplinary curricula and shared learning between different sectors of society.

6 Complexity in science-based policy making[29]

Kaisa Lähteenmäki-Smith

These are some reflections from a Finnish perspective on complexity in politics looking at the relationship between facts, perceptions and evidence-informed policy in an imperfect world. They arise from experience close to the centre of government.

A critical question which is always present is can politics and evidence-based decision-making be reconciled? A case can be made that evidence-based management is an inherently political project that creates an illusion of rationality which masks the underlying fundamental differences of interpretation, purpose, and power among the interested parties from both the academic and the political sides. From the political side there can be a tendency to reject the scientific perspective in that it can raise too many doubts and become paralysing, especially where it exposes a wide span of risks. Risk aversion can lead to defensive decision-making.

The advantages of experimenting from the experience of the benchmarks are:

- *compiling information and scaling of lessons*: making information and experiences, lessons learnt available and accessible (data = measurements, examples, narratives, data bases)
- *effective implementation*: better results, economic efficiency and quality of outputs
- *development of the policy process itself*: better management practices, policy design and architecture (design, implementation, evaluation) – experiments as part of the *governance portfolio*
- *cultural change*: a more responsive and inclusive government activity, in closer dialogue with citizens

Faced with complexity (wicked problems) the aim of policy is to identify the challenges, develop a comprehensive big picture, and develop user-friendly and relevant answers and solutions. In Finland the five principal objectives in the government programme are (1) improving employment and competitiveness; (2) reforming education, skills and innovation; (3) promoting health and well-being; (4) enhancing the bio economy and clean solutions; and (5) reforming ways of working through digitisation, experimentation and deregulation. The last point is significant because it opens up the possibility of developing policy and using evidence in new ways. This is being called "a culture of experimentation" as a key project in the government programme.

Some components of this programme are shown here.

The programme is summarised as follows.

"Experimentation will aim at innovative solutions, improvements in services, the promotion of individual initiative and entrepreneurship, and the strengthening of regional and local decision-making and cooperation. Experiments will make use of citizen driven operating practices. An experimentation programme, including extensive trials and several smaller experiments, will be implemented. Systematic experimentation will be introduced and a legal basis will be created to make the arrangement of experiments easier. Experimentation will reduce response times and improve anticipation during the process of solving social problems and the government's strategic aims will be promoted".

The study into funding experimental activity through government was structured thus:

- *Starting point*; ensuring smooth financing that is properly targeted is an important element in the transition to society that advocates piloting and experimenting
- *Objective*: Between November 2015 and March 2016 the KORVA project will formulate an understanding and recommendations for measures that help ensure smooth funding for pilots and experiments
- *Network*: Experts and researchers from Demos Helsinki and Finnish Environmental Centre and a network of 'Goodwill Ambassadors' for experiments (Kokeilukummit)

This is changing the role of the government unit responsible for supporting and enabling experimental culture cross the government. The roles it needs to discharge are:

- Bringing people together
- Facilitating building new relationships that help exchanging ideas, research, knowledge, shared needs and interests
- Connecting (knowledge users with knowledge producers), linking ideas, bridging multiple domains, teams or groups
- Act as an intermediary and "a human force behind knowledge transfer"
- Translating knowledge from a discipline-specific and technical lingua into plain language, understandable by end-users.
- Sense-making: helping people to make sense of and apply information, making it relevant for them.

The key needs which have to be satisfied for this to work are shown in the slide below. The double headed arrow indicates there is a close relationship between the layers. Experimentation of this kind requires a different understanding: it is done in real environments with real users in real time rather than in an isolated laboratory. In this way a policy or service can be tested and its impacts assessed before scaling it. There is also a cultural change from planning to doing to discover what is appropriate and effective. This changes the relationship between policy formation and scientific evidence.

Figure 8 – Hierarchy of needs for experimentation

7 Complexity beyond national boundaries[30]

Nigel Topping

Beyond the national is a global scale of complexity with a wide diversity of interested parties. A recent example of this was the COP21 conference in Paris in December 2015 which brought together multiple parties at multiple levels. These are represented in the Figure 9.

Figure 9 – Levels involved in the COP21 Negotiations

At the global level is the supranational interest in the planetary challenge of climate change. This is held within the United Nations Framework Convention on Climate Change (UNFCCC). At the next multinational level there are representatives from 196 Nations. Prior to the conference there were many other groups, international, national and specialised who were contributing inputs for the discussion. This is a huge context of complexity within which to achieve an agreement. It represents a tremendous challenge as to how to forge a global agreement given a long history of entrenched differences and disagreement. In process terms it was clear that to be successful this would require something different.

In fact, the conference did achieve a consensus, the Paris Agreement[31], on the limiting of global warming to less than 2° compared to preindustrial levels. Here some aspects of the process are discussed rather than the content.

The fresh ingredient that came into the conference proceedings can be summarised as ‘a diplomacy of love’. This is contrasted with the more prevalent diplomacy of power. Love here is taken to mean not an ephemeral feeling, but a very exceptional adherence to a number of behaviours that are rarely present at such conferences. These include inclusion without exception, appreciative listening to all positions, considerable patience, tactical skill in bringing the needed positive influences to bear at the right time in the right place and not allowing the complex dynamics of the process to distract from the principal layman values of the gathering.

This was made possible by the dedicated facilitation of a core group of diplomats and their staff led by Laurent Fabius, Minister of Foreign Affairs and International Development of France and President of COP 21. Before the event he declared “It will be my role to get across this message with a single aim: to achieve in Paris on 11 December the success the whole planet is expecting.”

Remarkable were the declarations by nations that had always felt side-lined or suppressed, reporting their experience of being listened to, taken into account and included.

This event is, perhaps, one of the most striking historical encounters between science (in this case climate science) and policy (in this case agreement on what the collectivity of nations needs to set out to do). This, in itself, does not mean that the agreed targets will be achieved. That remains to be seen. But in terms of evidence-based policy this represents a step from disagreement about whether the science is to be acted upon and whether nations can work together to even share plausible targets related to the science. More importantly, in the context of considering second-order science and policy, it reveals the prodigious complexity gap that exists similarly in all major planetary issues and raises the question as to whether second-order science might provide a softer landing between the turbulent world of diplomacy and the hard data of first-order science.

8 Complexity beyond the disciplines[32]

Alfonso Montuori

Disciplinary specialisation has produced an overwhelming amount of information, and proved to be enormously generative. At the same time, it’s increasingly unclear what to do with all this information, let alone how to apply it or even begin to think about it, because it mostly remains buried inside the walls of a specific discipline. Particularly during this time of perilous transition and uncertain futures, this is a dangerous state of affairs. Along with disciplinary specialisation, we need integrative transdisciplinarity, an approach to knowledge and inquiry that’s marked by creativity, integration, and application, bringing theory and practice in the crucible of the lived experience of self-reflective, creative inquirers who also actively participate in the world.[33]

A transdisciplinary practice requires understanding the nature of creative groups. But until recently study and research into this has fallen between the cracks of psychology and sociology. The way we organise our thinking and institutionalise it is deeply problematic. Transdisciplinarity does not reject specialised research but addresses the need for integration which in turn has implications for policies to effectively address the needs of society. This requires a different kind of scholar, one who integrates. There is an explosion of accessible information but who is putting it together to make sense? Who is being trained to integrate this and also bridge its relevance to practice? We see the gap between the scholars and practitioners widening – we don't seem to be talking to each other. So the question is how do we bring these two together?

How can we generate questions not from the discipline, which has its own agenda, but from the situational challenges; inquiry driven rather than discipline driven? The issues going on in the world do not fit neatly into single disciplines. We need to let the questions emerge and explore whatever is relevant from whichever disciplines and from that develop pertinent knowledge.

Historically academics have not been very good at working together. We are much better at critical destruction than we are at being collaborative and generative. If you begin from a challenging real world question and you have an intuition, then that intuition is fragile and easily stepped on. Part of transdisciplinary is this ability to be together with others and keep the space open to generate ideas together respectfully with others and be able to play with ideas for a while. We allow the seeds of thought to have a chance to germinate and show themselves a little more before we apply the critical mind. Transdisciplinarity includes an attitude of sensibility that requires unlearning some of the things that we've been taught as to what it means to be a good academic. It requires learning how to go broader as well as deeper.

A critical obstacle to cultivating transdisciplinarity is that we soon find ourselves in territory where we are not an expert. Knowing the answers is not a position that fits and this is also the position of policymakers facing the complexity gap. Thus it seems that a transdisciplinary approach would be more resonant as a bridge between science and policy. However this requires questioning the degree of ego investment in being an expert and being able to handle a different relationship with disciplinary peers. The practice requires a transformative shift at the personal level.

Education for transdisciplinary practice requires some components not often found in traditional higher education and research. Students may have to go through an unlearning process of some of the forms of thinking that have succeeded in their specialised domain. Also the ’production line’ approach to education has tended to neglect broad knowledge and even capacity for critical thinking. For transdisciplinarity to succeed critical thinking is even more important in terms of being able to recognise and question underlying assumptions in different fields.

So the proposition here is that science-based policy that is based wholly on specialised disciplinary advice is likely to run the risk of increasing the complexity gap. The practice of transdisciplinarity would be able to improve this by being able to build an intermediate bridge between the policy world and the science world.[34]

THE WORLD OF TRANSFORMATION

9 Transforming Livelihoods in the face of Big Changes[35]

Glenn Page

There are situations which challenge the livelihoods of people in a way that forms no recognisable definitive problem. Instead, there is a set of intertwined problems, none of which can be simply isolated. A good example of this is from the coastal fishing communities in Ghana. Several major issues overlap: expanding population and insecurity; changes in the biodiversity of the region; competition among fishing fleets; the introduction of oil and gas development; and overarching these, climate change. In such a situation there is no clear solution or end point.

The catch of the different specieis of fish shows the broad oscillation over a period of 20 years close to the present. Although catches can decline steeply they usually recover. However, some species have gone into rapid decline. Figure 10 shows the change in how long it takes to get to a productive fishing ground, comparing the present with 10 years ago.

Figure 10 – Increasing distance to productive fishing grounds

The whole of this challenge is embedded in a complex multi-level web of local, sub regional, regional, national, and global relationships such that conventional policies on their own are likely to fail the local communities (Figure 11). It is necessary to search for where real power and love is hidden which is with the women of the community. If each local community can develop its own sense of initiative and responsibility in caring for its coast and its future then, through appropriate non-traditional metrics it is possible to enable the different levels to connect together in a way that favours the emergence of new viability.

Figure 11 – Stakeholder relationships

For this to work all stakeholders need to agree on key principles of ecosystem governance. These governance factors are summarised below.

- How a resource or an environment is used
- How problems and opportunities are evaluated and analysed
- What behaviour is deemed acceptable or forbidden
- What rules and sanctions are applied to direct how natural resources are allocated and used across multiple scales

10 Transforming agriculture holistically[36]

Christopher Cooke

Agriculture is a prime candidate for transformational change. On the one hand the extension of first world lifestyle to the global population is beyond the agricultural resources of the planet and on the other hand the stresses on the planet are diminishing agricultural productivity, especially through degradation of the soil, at an ever-increasing rate. The main imperatives for change are summarised below. It is clear that ‘business as usual’will not be maintained for long. Consider the following imperatives for change:

- For every ½ tonne of food produced, 10 tons are degraded
- Vital signs of the need for change – The bees
    - Too complex for science

- Massive reduction in bio-diversity
    - Sepcies level extinctions
- Practical ‘myths and norms’ that lead to long term social collapse are still upheld
    - Fire; Rest; Livestock; Health
- Nutritional density of food decreasing
    - The root cause of vitality
- Commodity price volatility
    - Economic subsidies leading to unintended consequences
- Democratic ignorance
    - Source of food
    - Relationship to health
- Synptomatic legislation
    - Nitrates
    - Indicator species
- Aesthetic supply chain
    - Size; uniformaity; appeal
- 2nd order innovation held back
    - Soil vitality monitoring

However, transformative change is already underway, albeit not yet on a scale that will turn the situation around. Of particular significance is the role that soil plays in sustaining any civilisation. Increasingly this is being recognised. Some of the changes underway surrounding this development are summarised below.

- Organic; Biodynamic; Regenerative; Agro Ecological; holistic approaches
- Microbiome now on the agenda – holistic enquiry and scale dependant science and solutions becoming legitimised
- Confused customers – for example, angry vegetarians and vegans
- Economic legitimacy through true cost accounting, natural capital and circular economy concepts
- Food activism; for example farm to table and gorilla gardening
- Human creativity and innovation responding to challenges such as the 30 year drought in Australia; ‘certain hope in an uncertain world’
- Virgin earth challenge: 2of 11 finalists are focused on soils carbon induction
- Factor 50 → 100 innovation possible through improved soil carbon induction levels
- Changing the language; for example. From dirt to humus

This crisis requires good science to be applied but it is beyond the traditional sciences. Similarly holistic management is required beyond the conventional approaches to land management. Account must be taken of the interdependence of earth, life, humanity and the cosmos and the role of soil in this highly interdependent system understood. Soil needs to be seen as humus rather than dirt.

Figure 12 – Layers of evolutionary complexity all of which need to be healthy

Understanding the critical role of soil means understanding its complex nature and the role it plays in the total ecology. Especially important, and increasingly the subject of serious research investigation, is the role of microbes and their transformative role between the world of chemistry and the world of life. Traditional agriculture has tended to bypass this through a reductionist worldview.

Holistic management of agriculture[37] seeks to redress this mission and consider the full range and scale of community dynamics of an ecology as in the slide above, whether it be farm or Savannah, and regenerate agriculture through reintegrating it with nature.

11 Transforming health care to be human[38]

Linn Getz

In contemporary medicine, research in general practice is often at the margin. We have a situation where a single disease approach is dominant whilst multi-morbidity is prevalent. Great success in specific areas is matched by stagnation in many aspects of basic healthcare. There is a tendency to take a "one size fits all" approach. The problem with evidence-based medical policy is that it is based on fragmentation and hyper – specialisation. This leads to even general practice to be under siege as a "holistic" discipline. The implications for the real health of real communities are serious.

For example, the BMJ published an article under the heading 'Evidence based medicine: a movement in crisis?' In this essay Trisha Greenhalgh and colleagues argue that, although evidence based medicine has had many benefits, it has also had some negative unintended consequences. They offer a preliminary agenda for the movement's renaissance, refocusing on providing useable evidence that can be combined with context and professional expertise so that individual patients get optimal treatment.

The human being as a whole system is juxtaposed against a medical practice which is divided into silos. Since this is the dominant mode of the profession and also of its funding it presents a considerable challenge to sustain and develop responsible preventive medicine which it leaves riddled with ethical dilemmas.

Figure 13 – 'Silo medicine' versus Multimorbidity

The result is over-diagnosis, over-treatment and unintended harm. Costs of specialisations escalate, services to the sick are cut and there is increasing inequity. This dehumanisation is nothing less than a crisis of care. There is considerable tension between the humanistic and the techno-scientific medical milieus. The humanistic voice of the authentic general practitioner is drowned in the explosion of techno-scientific data.

A major confusion in this tension is that both claim the future as the personalisation of medicine. However, focusing on the person takes very different forms in each of these paradigms. There is a risk that without the participation of the human to human holistic understanding we could find ourselves in a new kind of medical witchcraft except that the crystal ball and the cauldron become replaced by uninterpretable clouds of billions of data points. Whether there is a Renaissance of the person in medicine is an open question.

12 Transforming education for the future[39]

International Futures Forum has been particularly active supporting transformative change in education in Scotland. The starting point is the report of the UNESCO Commission on Education for the 21st Century chaired by Jacques Delors, *Learning: The Treasure Within.* This suggested that the core competencies for the 21st century are to learn to be, to do, to know and to live together.

Various countries have adopted versions of this agenda as the basis for their education policies. That includes Scotland, which introduced the 'Curriculum for Excellence' based on developing versions of these 'four capacities' in all pupils. The Curriculum for Excellence is a new form of policy: it is enabling and permissive. It specifies the ends (development of the four capacities) but leaves lots of flexibility for the means. The then Education Secretary declared: "The vision for Curriculum for Excellence is to achieve transformational change in Scottish education."

Supporting this kind of permissive policy framework and realising its transformative potential requires a different kind of support system from the norm. Ordinarily policy is enacted and practitioners – in this case teachers and education authorities – await guidance form the centre on how to implement the policy in practice. In this case what was needed was tools, frameworks and processes to enable teachers and education authorities to think for themselves, to expand into the permissive space provided by the policy.

IFF entered a partnership with Education Scotland (the inspection and improvement agency for Scottish education) to provide this kind of support. They first introduced the Three Horizons framework to help people think through a longer term transition from failing first horizon systems to visionary third horizon systems, via a series of innovations in the second horizon. The opening up of the gap between first horizon reality and third horizon vision allows us to make a distinction between 'sustaining innovation' that will improve existing systems, 'disruptive innovation' which will shake those systems up, and 'transformative innovation' which helps to shift the system as a whole towards a new pattern of viability fit for the future.

A 'Three Horizons Kit' was developed to enable all schools to do this thinking for themselves. It was then backed up by a set of tools for translating insight into action – IFF trained members of staff at Education Scotland in their use so that they could then support schools to pursue transformative innovation.

The bottom line is that it is not easy to work against the grain of dominant cultures in this way. The first horizon has a strong gravitational pull: it is where the money is, the research grants, the awards, the promotions for good performance, and is the centre of gravity for the public and political debates – even though we know in our heart of hearts that it is fundamentally unsustainable. People need to be supported if they are to undertake the work of transformation: one of the IFF rules is 'no solo climbers'.

Figure 14 – From the three Horizons Kit for Schools

Finally, policy and finance could be designed much better to support transformative innovation. A policy framework for transition between one system and another needs to include a vision of how the system needs to transform, encouragement for those pioneers who are willing to set out on the road to get there, a realistic view of the dilemmas and challenges they will encounter in the policy landscape (the need to keep improving the old even while introducing the new – redesigning the plane whilst flying it), and evaluation based on the new system not the old. Finance also operates differently. Transformative innovation requires little up front financial investment – it is about a change of mindset and of practice rather than new technology or expensive reorganisation. But it does need financial resource once it starts to prove itself – when it will no longer count as new and does not have the weight yet to replace the old systems.

Transformative policymaking requires both a policy framework for transition, a financial framework to match, and specific supporting infrastructure for transformative practice.

THREE DIALOGUES

Introduction

A challenge in convening a forum of this type is that a capacity gap exists at the level of designing dialogues so that transdisciplinary understanding can be constructed around the inquiry question. The task in this case was to create three parallel dialogues to explore different perspectives generated by reviewing over 70 questions raised by the reflections on the original talks reported in Section Two. Out of many possible clusters of questions the themes of greatest interest were:

A. The significant features of second-order science
B. The context of evidence-informed policy making
C. The challenge of uncertainty

An account of the process is given below so that the reader can have some sense of what is involved in entering into and carrying through this kind of dialogue.

1) The primary question of the forum is borne in mind: *How might emerging second-order science contribute to policy development and evolution in the future?*
2) The set of questions (written on moveable sticky hexagons) where clustered as a process of identifying possible themes. The three themes A, B and C (above) were selected from these possibilities.
3) After dividing into three groups, each group in parallel exchanged views about the theme and its subsidiary questions gaining a multi-perspectival view. This was sketched on large pin boards (see pictures). The main questions gathered together appear in the first paragraph of the dialogue reports below.
4) The angles of vision became more aligned through discussion and helped home in on significant characteristics
5) The lively exchanges between people stimulated further thoughts and surfaced other relevant information. This process was intensified by two exchanges of people between groups, blending the perspectives.
6) The representations on the pin boards then provided the basis for three reports to the plenary group on what had been generated. These reports are the foundation of the record given in this section.
7) Reflections on the picture that emerged were shared.

The essential considerations of the three dialogues are reported below.

Significant Features of Second-order Science

The question cluster

A number of questions came together to trigger this dialogue. What are the limitations of a policy driven by first order science? How is this influenced by the institutionalised practices of first-order science? In contrast, what is second-order science? How might it relate to policy? What is it that second-order science can reveal and why is it important? What kinds of knowledge are considered legitimate in different contexts, for example the organisational and the personal? Overall, what is our boundary of "science" defined as reliable knowledge? If there is an additional value potential in a second order approach, what is that value? Given the limits of first-order science in addressing the future (evidence is restricted to the past), is second-order science better able to address the future whilst retaining reliable knowledge? Given the complexity of the operating environment could second-order science enable a more holistic view of current specialised silos of science?

The exploration

The exploration triggered by these questions began by considering what it is that second-order scientists do that first order scientists don't. The task was to clarify the factors that distinguish second-order science from first-order science. There is a very particular meaning to the term second-order as a different level of operation, as a different way of doing things. However, there are factors that we associate with second-order science which can also be present in some forms of first-order science. For example, anthropologists are very aware of the impact of the observer on the observed. Three of these common factors were identified as

1. the observer is included in the system under investigation and is *not* independent of what is observed
2. truth is considered to be relative to the observer's perspective and is not absolute
3. any form of science is normative in that it affirms a worldview

However, it should be noted that in most sciences, especially the physical ones, the dominant approach tends to be that the observer must be excluded in order to achieve 'objectivity', truth is often considered to be final and absolute, and the normative aspect of science is either considered un-discussable or simply 'not science'.

4. Second-order science complements first-order science
5. Re-entry is a basic operation in the second-order level of operation
    - Why is it the same concept re-entering? A concept or field is referenced to itself (Spencer-Brown[40] – something re-enters its own domain.) This has the effect of opening up new domains of research.
    - What is the difference between re-entry and meta-analysis? In meta-analysis we are bringing lots of studies together and reflecting back on that observation.
    - Meta-analysis can support quality control by the inclusion of a wide range of researches in the same field. This differs from simply review (as often occurs in medical research) in that deliberate rules of re-entry are applied.
6. Reflexivity is inherent. It does not have to be the same as in re-entry. It could be any other operation of gaining perspective.
7. Intervention is acknowledged; non-intervention is itself an intervention
8. Second-order has multiple disciplinary perspectives – transdisciplinarity.

- This depends on the framing of the research question. The question itself can be discipline focused or broadly interdisciplinary or arise from broader considerations.
- There is also the re-entry approach of models of models, theory of theories and so on. Can you come up with a more general model that generates some of the specific models occurring in different disciplines?

9. Second-order can move to post-disciplinarity in constructing a new paradigm

With some aspects of second- order science, is there a risk of moving into generality and losing contextual knowledge? It is important to emphasise both local contextual knowledge and the high-level connections and interdependencies; we need evidence on both. We currently tend to operate only in the middle. The most generic of understanding raises a question you might want to investigate in the local context. Where do questions come from? They come from the deeper pool of generic understanding. Questioning the questions indicates a different layer of operation perhaps leading to a new way of understanding. If we are going to be using second-order levels of operation we need to be thinking quite differently. What other ways besides re-entry are there to help us do that?

Science itself is an intervention. Introducing intervention changes the context of the primary operations of second-order science.

Further considering the question “what do second-order scientists do?” and taking the observer as the active investigator, what does this mode of study reveal? An analogy is when the Santa Fe Institute research first came out talking about complex systems. That provoked thinking that determinism had been a rather limiting assumption. So a whole class of phenomena became amenable to scientific investigation but only because science itself had taken a step in letting go of some underlying assumptions. Can we discover the same simplicity in this step to second-order science that reveals a layer of further assumptions that we can now let go and opens up yet further phenomena for investigation?

Could we formulate second-order science as the study of observer/participant dependent systems bringing them within the realm of first-order scientific inquiry? This would be a class of things where what is salient is the way the participants pay attention to the phenomena and use metacognition to choose the mode of attention such that different things come into view and become amenable to their skilled action and intervention. This may not make any difference to, for example, studying the origin of the universe. But it is certainly the case for, say, the management of ecosystems where choosing what to bring into view causes a reflexive effect on what happens. In this context ‘observer’ is not quite adequate term. Observer/participant might be better. This also implies that no scientific knowledge is complete. As with complexity, you can never pin down the initial conditions sufficiently to have full knowledge of the system. Similarly, you can never pin down people's ethics, let alone what they had for breakfast, to determine what they will do tomorrow.

Reflecting on this from the perspective of a science of qualities and true participation, there is more to be brought out. Building on the notion of real and counterfeit wholes, Bortoft distinguishes two modes of consciousness: analytical and holistic. A similar study of holistic consciousness is the work of Francesco Varela which includes a meditative kind of practice as part of the whole you are observing. You allow the thought that you can have intuitive insights and aesthetic perception of wholeness and rightness in a complex system. This can be practised, for example, on the health of ecosystems. You can walk into a forest and perceive the health of its ecosystem directly, not by an analysis of all its material and biological components. Such practices require researchers to make space for bringing modalities that most conventional first-order scientists would strongly reject as ’not science’.

Brian Goodwin argued that if you take observer participation seriously then a discipline to see the ‘coming into being’ of phenomena is necessary in the act of observation. This is a rigorous practice that does not come lightly. This approach opens up new approaches to insight generation which complements deep knowledge of a first-order kind. Indeed, these approaches can involve all the senses through which you receive vast varieties and amounts of information.

Referring to the history of creativity in science, there are many accounts of breakthrough insights which are not reported in the official literature but include a range of ways in which insight, discovery and hypothesis formation actually occurred. The person of the scientist making the breakthrough is not separate from the turmoil of the breakthrough itself.

This group concluded that second order science opens up the possibility to bring in and innovate new methods. It is an important challenge for further work to gain a more comprehensive overview of what is out there already.

The salient points

To sum up, these are the main characteristics of second-order science that are considered worth exercising to get the feel of a second-order thinking and practice for exploration of the world from within.

	Characteristic	Comment
1	Observer included	Observer may also be participator, decider, actor
2	Truth is relative	Truth is generated from multiple perspectives including reflection on the truth
3	Its norms are revealed and discussable	Contrast with first-order science the norms of which are often taken for granted and even removed from questioning
4	Introduces new characteristics of inquiry and valid knowledge	Opens up additional possibilities of genuine novelty that transforms familiar forms of first-order science
5	Re-entry as a basic operation	This is essentially a disciplined acceptance and treatment of circularity that is normally eschewed in normal science
6	Reflexivity on the part of the scientist	The first person is acknowledged and self-observation is used as a way to clarify sense-making and understanding
7	Intervention universal	A view that that so-called objective science is also an intervention and is not neutral
8	Emergence from multiple perspectives – dialogic transdisciplinarity	Scientific understanding is a never-ending social construct that is continuously being reframed by generation and juxtaposition of different perspectives
9	Post-disciplinarity	The emergence of a new phase in the overall scientific differentiation process which introduces new connectivity patterns operating on different levels.

The Context of Evidence-informed Policy Making

The question cluster

Some of the main questions that emerged from reflection on the contributions from the complexity and policy talks included the following. What are the commonly perceived barriers to the policy - science dialogue? How does evidence inform policy? What are the implicit boundaries around what counts as evidence? How can we fuse incentives for policy adoption into policy design? What helps policymakers reframe their perspectives and understanding? What are the implications of seeing first-order science as an intervention?

Going further from these general considerations the possible relationship between policy making and second-order science led to questions such as: How might second-order science assist implementation? Which communities could second-order science serve? Can we identify phases by which second-order science brings about societal and systemic transformation? How does second-order science and policy hold a meta-stance for meaningful action?

The exploration

The general approach adopted here was to examine the relationship between complexity governance and the generation of advice.

The initial discussion reviewed the current ways in which science typically impacts policy in Western governments, especially the UK. A key feature is that there is a channel or filter of judgement between the science that scientists may consider relevant or that has been commissioned by government, and the actual attention paid by the policymakers and politicians. This is symbolised in the sketch as a letterbox in the wall of the relevant government department: the main arrow represents the flow of papers and recommendations that reach the policy domain. This might occur directly, or else via the channels of Chief Scientists and their teams in the different departments. The worldview and mindset of scientific research can be significantly different from the worldview and mindset of policy and politics and therefore this communication is not necessarily straightforward. Also, whereas a field of research may be relatively stable over time, the personnel in the offices of policy are often changing, and governments and ministers also come and go.

In addition to these direct channels of communication there are other intermediate agencies and institutions that will transmit information to the policy field. Increasingly there is the media and public domain where topics can the heated up irrespective of the way that politicians might want to prioritise them or researchers present them. It is also important to note that the prevailing values in government can have a strong effect on the orientation of learned journals, funders, and the universities themselves. So there is a circular relationship in the system. This influence is further amplified by the role of intermediate and even international agencies (e.g. research commissioners).

It was also discussed how there is a complex and oscillating relationship between evidence, application, impact learning, and research. This can also be overlaid by the prevalence of fashions and factions around the relationship of science and policy. This is also strongly affected by the degree of involvement of the public both in the general understanding of the science and the issues which are of particular prominence in different sectors of society. This is the arena where public dialogue around science (in so far as it takes place) is an important factor.

Another area of discussion centres around the notion of levels of policy, the place of subsidiarity and how politics is managed to determine the range, purpose and intent of policy initiatives. The notion of subsidiarity was further linked to the idea of recursion as in, for example, the viable systems model of Stafford Beer[41]. A key question at the heart of this was how we can determine at which level a decision should be shaped and taken. As an example, the VSM can model several levels of recursion. It is possible to imagine – and many have - an ideal policy system from the global to the local with several intermediate domains which are not, in this approach, a conventional hierarchy. The challenge in this ideal design is that you would then need a level of decision-making about where decisions should be taken, and which scale is appropriate. This meta-decision process would call for dialogic processes and these processes would be in themselves a form of social learning quite different from current governance structures. Criteria for placing decisions at a given level would have to be developed and continuously clarified.

Further conversation led to recognition that there is already an experimental culture emerging in policy circles as a response to complexity. For example, the idea of 'labs' to develop experimental approaches at small scale is now common. The current experimental culture is about trying something out and finding out whether it works. In this approach failures are acceptable as learning and successes become prototypes for trying out on a larger scale. However this form of learning is still pretty much first-order. A second-order approach might adopt spreading rather than scaling; and adaptation rather than replication. So the challenge becomes how to work science and evidence into policies that acknowledge complexity and uncertainty, and are sensitive to different contexts.

This can be better understood through the Boisot[42] learning cycle. Also considered relevant is the experimentalist governance frame-work of Charles Sabel[43] from Columbia University. Start with local contextualised experiment, then extract the general principles, and spread them to another context where they are adapted to the new circumstances, which leads to new experiments and different learnings.

The very condition of allowing adaptation allows the unique professionalism and qualities of the people who do it to come in, whereas the rationalistic approach is squeezing out that innate professionalism and humanity – often the original reason why people feel they are doing the job at all. A good example of this can be seen in agriculture with the emergence of mega-farms. Given microclimate and technological differences between different farms, standard approaches do not work as well because they do not take into account the local understanding of specific farmers.

Returning to the question of subsidiarity, how do we determine the level at which decisions should be made? In highly complex situations we should decentralise decision-making to utilise all the brainpower of the organisation. But if there are multiple levels how do we decide what is being decided at what level? The Sabel model turns the usual top-down approach on its head. It starts to build from the local context, bringing it to the next level, trying to codify what is generalisable. This can be taken to the next level and spread. It is the relevant contextual knowledge that should guide decision authority at different levels. People who know the grassroots take decisions at their level but always in the context of higher systemic levels where there is different contextual knowledge and so other people will be responsible for decisions. The European definition of subsidiarity is that decisions should be taken as close as possible to the people most affected by them. The role of the next level up is to coordinate and enable. As the European debate has shown, this is fine in theory but questions of consistency across levels are themselves political rather than technical – there is no easy technical division possible.

If a sufficient number of local contextual policies are tried out then it is possible to develop a next level typology of these local contexts. A good example is environmental restoration projects. There are lots of ways to regenerate soil but depending on what climate zone you're in you determine which are appropriate for a given case. However, there are problems of consistency in communication between levels. A statistic that shows a number of successful experiments can lead to the evaluation that it is applicable generally but does not reveal the distinctions that will cause it to fail in different local contexts.

The issues of policy level and where it comes from raises the question of which societal arrangements lead to effective action. We are used to thinking in terms of institutions, communities and individuals. But in the face of policy failure this interpretation may be an error in framing. An alternative framing is that of ‘social integrities’, defined as coherent networks of people cutting across the usual categories that can collaborate to get things done.

A social integrity has the autonomous power to act where an institution, organisation or individual may be powerless. Yet it is also integrated into the wider whole and therefore is not anarchic. These properties of autonomy and integration are characteristics of the holon as originally described by Koestler[44]. Holons functioning within holons form a holarchy, quite different from a hierarchy which suggests a more subtle meaning to ‘subsidiarity’ which otherwise tends to assume a conventional hierarchy. Perhaps a social integrity requires a degree of second-order awareness as a condition of maintaining its integrity in a transformative role? This means that the people within them are taking responsibility and are calibrating what the system does according to their own sense of capacity. Adaptive realisation in different places then is a process of recognising different levels of maturity and skill. Responsibility is sustained and distributed by the delegation of integrity to a given level.

The salient points

Given the current power structures and institutional arrangements, how can we change the science/policy dialogue to second-order? And how would this help? Making progress with these questions will need a much clearer picture of what the benefits of a second-order approach can be for scientists seeking to influence policy on the basis of what they have learned and what the benefits for policy makers can be if they can extend the range of modalities of science upon which they draw. It seems the existing structures and cultures are generally poorly set up for this.

The domination of science to inform policy by quantitative measures and statistics is a major factor that supports the domination of first-order science. However, a promising sign is that evaluation is experiencing a rapid transformation. The majority of evaluations are still in a normative summative model, but the considerations in this discussion are also present in the emerging field of developmental evaluation. This is putting the evaluator in the process not outside of it. It is thinking collectively about where the context has led to a programme or intervention based on ecosystems and adaptation thinking. So there is a parallel universe of evaluation that is coming to the fore. In evaluation we have the step of including the observer in the evaluation. And also we are seeing increasingly evaluations of evaluation which is a second-order re-entry.

The Challenge of Uncertainty

The question cluster

There were two aspects to this conversation. One focused on the implications for applying science that acknowledges uncertainty in the policy domain. The other focused on the kind of competences that need to be developed to enable the practice of second-order science. Some of the questions which triggered this exploration are included here.

Do we need special systems to cope with peak complexity? How do we ensure the legitimacy of public opinion in scientific dialogue? Can we declare a “state of emergence" in response to looming crises? Can we create social learning cycles? Can we identify phases by which second-order science could bring about societal and systematic transformation? Can we work with contingency and uncertainty in science? Does second-order science have a role to play in moving us to effective action? Is anything infallible? Is second-order science a response to different kinds of uncertainty or ignorance?

Does the practice/theory divide serve the emergence of second-order science? How important is ‘scientist’ as part of a researcher's identity? What is the role of courage, hope, cunning and empathy in second-order policy-making? What helps policymakers reframe? What processes bring worldviews into view? What kind of questions would I ask from a second-order perspective?

In the face of major complex challenges, what will move us to more effective action? Does second-order science have a role to play?

The exploration

The conversation here explored several dimension of the kinds of uncertainty and ignorance that show up in the policy domain, especially in the international context. One area of unpredictability is the emergence of many simultaneous initiatives on the same theme which creates conflicting signals about the future. This is not straightforward since there are interests who create diversionary initiatives to pre-empt certain kinds of action or close actions down. This can be amplified by media interests and create bandwagon effects. There is typically around any policy issue a tension between those in favour of a certain approach, those against, and those in the middle (often the majority) who are confused by these two strongly held positions. In efforts to resolve these disagreements there is often an assertion of overconfidence and the privileging of interpretive models that do not stand up to scrutiny in the footnotes. All this leads to a key question when initiatives fall into the void: whose responsibility is it to fashion a response and to take action?

The conversation moved on to the issues of uncertainty and whether second-order science could be viewed as response to different kinds of uncertainty and ignorance. What this really means in terms of competences was also considered. A trigger question for the policy field was: how is the context of uncertainty now showing up in an entrepreneurial public policy activist?

Paradoxically, uncertainty often shows up where there is over-certainty and overconfidence in certain things that are being put forward contrasted with the actuality of the situation (which is often hidden in the footnotes). Another source is the emergence of many initiatives around a theme and an unpredictable mutual resonance between the initiatives. These are often accompanied by value-laden statements. Another aspect is that there is greater research on existing practices which feeds actors’ expectations. There can be a greater response from the research community around certain practices and that can signal doubt that these practices are really working. Another major factor which can disrupt expectations about the future is the role of the media which can amplify certain things and ignore others thus changing the landscape of expectation. This might also be a diversionary tactic to change the attention towards the future in ways that might pre-empt or close down possibilities. The generation of dissent also creates confusion and uncertainty. A further source of uncertainty is the ambiguity around who is responsible for what. Even if good ideas come forward there is increasing lack of clarity as to where those ideas should ultimately be handled. Where should responsibility lie and will it be taken up?

There is often a mismatch when science is brought to bear with a thoughtful analytical rigour as to what might be the barriers to implementation. It is often simply the assertion "you must do this" without an analysis of context rather than: "if you want to do this then you should pay attention to that". This indicates a need for improved ways of framing recommendations. It is not enough simply to assume that good science dictates wise action.

It is clear from the above survey that the position of first-order science which excludes the observer from the process does not give an intelligible link between the subjective world of policy and politics and the objective world of knowledge. Second-order science which includes the observer may offer a bridge or reconciliation between the two worlds, providing its role includes the making clear of presuppositions, assumptions and worldviews. Of course this is not straightforward because such a process may contradict the power-play of vested interests. So a further topic of the conversation in this group was to consider what the competences of a second-order science community would need to be to play an effective role in the context of the complex and unpredictable stakeholder dynamics.

An ideal of specialists with breadth leads to the idea of the T-shaped competence for second-order scientists, capable of grasping the broad whole as well as a specific deep focus. A view was expressed that in the link between science and policy, facilitation has an important enabling role to play. One of the roles of the broader holistic view is to indicate and acknowledge blind spots – what are we not seeing that could derail policies? This is helped by enabling multi-stakeholder dialogic processes, engaging effectively between disciplines. This needs to be coupled with the ability to reflect and let new thoughts come through. Other skills are seeing our own seeing (re-entry) and being able to lead from the emerging future rather than propulsion from the past. The experimental approach to policy means holding to truths as contingent and entertaining additional ways of knowing beyond the rational and analytic. Could the second-order science-policy team be the integrator building collaboration between all relevant stakeholders?

Some similarities with the properties of new emerging business ecosystems were identified which also seem to require this facilitation process. There may be similar capabilities involved – both are highly complex with multiple stakeholders and a similar context.

Given that we also need traditional first-order order skills, it is hard for people to be adept in both – the experience and training are different. This also begins to blur the distinction between what is research and what is facilitation. But there would have to be some mixing of an operational level and a second level of reflection. Perhaps you could still have a first order scientist doing re-entry and so classed as second–order? Also there is the balance between individual ability and collaborative competence.

How to create science systems that can deliver this? You need facilitators who may need to draw on science skills that cannot be identified in advance because it is an exploratory process. That is a unique capacity that takes us back to a much older way of funding science as capacity rather than through projects. This requires care – we need to be funding people to develop the capacity, in their science practice, to collaborate.

In cross-discipline collaboration there is a danger that we import the concepts and terminology but contain it within our prevalent model and so still do not discover and learn beyond the assumptions of our discipline area. Other people's technical language can cross into other disciplines simply as jargon (for example the use of 'DNA'). For second-order science we need the transfer to be at the level of meaning.

There is also the aspect of reflexive competences and what is the kind of training that will develop them? A specific person wishing to develop this component of second-order science will need something rarely available in our universities and research institutions: areas such as perception, mindfulness, self-inquiry, ability to 'think out loud', ability to reframe approaches to creativity and the like.

We also need creativity. This opens a Pandora's Box. Take postgraduate research. A Ph.D. dissertation is supposed to be an original contribution to the field and so by definition should be a creative process. A way of going about this that is (unlike many) consistent with this definition is one where we expose the students to the research on creativity together with a good deal of self-reflection because, apart from anything else, the whole process can be confusing and uncomfortable. This is one of the reasons why people give up on creative research. The urge to have an answer is too great. Having the 'negative capability', as Keats called it, can be difficult.

Once you are in the creative process the re-entry process gets us to examine the psychology of psychology, the sociology of sociology which means they're applied to not the observed system but the observing system. It's not just what is going on out there but what am I going through as an inquirer. We integrate the inquirer into the inquiry. The idea is to make ourselves transparent in the process and become aware of our biases and so on. That whole process is a second-order process because it gets you, the researcher, to explore your role as an inquirer. It involves looking at the various assumptions behind the perspectives we bring to bear on any particular issue – a meta-paradigmatic perspective of conceptual pluralism.

Another perspective on this is to treat the Ph.D. as a learning journey. What is necessary is honesty about the use of intuition and also the ability to reflect back and rationally unpick why that intuition contributed. So you can cover both the intuitive and the rational.

Could we develop an understanding of these new competences and create an ecology of how they can develop in different sectors of society, especially higher education. This would require that there was an adequate language for making and communicating the new range of meanings in the use of intuition to navigate complexity.

DARPA has some of these characteristics. They take on challenges that cannot be neatly specified and can pick multi-talented teams. However, they often have to hire consultants to tell them what they have done. There is not a complete second-order system within the institution per se. There is a whole institutional level. Science is practised in institutions supported by a community of practice. The role of consultants to an institution like DARPA is that they can shake things up and allow the members of the institution to reflect on the way they are doing things through a fresh lens. This brings to the institution a second-order perspective. These dynamics around an organisation aiming to do research need further examination. There is a strong relationship between the institutional and the individual in a science community. Another similar example is CERN.[45]

The salient points

It seems that a first-order science approach to uncertainty is that the researcher has a hypothesis that is tested with the data and excluding other impacting factors – so quite a simplistic uncertainty. If you include wider factors, other players and accept that you might not have the right theory, then this is a different quality of uncertainty. This requires a new frame or a reframe and the incorporation of other frames that you don't understand so you need a much broader approach to the range of uncertainties you might be dealing with. So perhaps second-order science is more realistic and could deal with more types of uncertainty.

What emerged from the discussion is the view that conventional futures and foresight methods are not so well developed to deal with these kinds of uncertainty and that a second-order approach to foresight might prove interesting and productive. This would involve being able to start with vague feelings of unease in the players and then move towards creating frames for understanding that would uncover new insights to inform policy. At this level it seems that we are creating the conditions for a new interpretation of subsidiarity. This would inform a process to propagate decision-making down to a wide social context. Achieving this would be extremely problematic since, unless there is a genuine delegation of authority and a licence to make autonomous decisions passed down, there is no reason to aggregate together as in the Ostrom eight principles. For reference these are:

1. Define clear group boundaries.
2. Match rules governing use of common goods to local needs and conditions.
3. Ensure that those affected by the rules can participate in modifying the rules.
4. Make sure the rule-making rights of community members are respected by outside authorities.
5. Develop a system, carried out by community members, for monitoring members' behaviour.
6. Use graduated sanctions for rule violators.
7. Provide accessible, low-cost means for dispute resolution.
8. Build responsibility for governing the common resource in nested tiers from the lowest level up to the entire interconnected system.

These principles of how self-governance of common pool resources can and does work is relevant. However, the full set of Ostrom principles[46] may not be necessary for extracting a shared understanding of a complex situation and for beginning discussions for how the principle of subsidiarity could enable a coordinated yet diversified range of resolutions at local levels. The relevance of the Ostrom principles will depend upon the level at which policy deliberation is engaged.

There is also a challenge of integrating decisions taken at different levels. This is characterised as the 'muddy middle' where the distribution of responsibility, authority and power is problematic. Much remains to be done on methods for this to work more widely. This might be an area where a second-order science perspective might help.

Also the issue was raised that there is a tendency for the assumption "certainty = good; uncertainty = bad". However, what we are seeking is recognition of the different modes of uncertainty and positive and creative ways of working with them. Uncertainty also can open possibilities and invite us into space for creative endeavour.

In the public context there are those who assent, those who dissent and the confused middle. Does second-order science require a second-order politics, second-order media, and a second-order electorate? In a public world that overly demands certainty there is no room for a second-order media. Science is regarded as advising certainty which makes it difficult for politicians to go against it. Some governments are even reluctant to appoint chief scientific officers because they are hard to disagree with in public. They try to counter that with another source of certainty - 'economics', which is actually highly dubious. Trying to get uncertainty overtly into the policy and political world is difficult. It may not be the case that science is not powerful in the policy domain, rather it has become too powerful. It almost has a veto power. But that can lead to it being ignored and side-lined.

Second-order Reflecting on Our Results with Our Results

Heinz von Foerster, one of the fathers of second-order cybernetics, referring to Socrates said "He knows that he knows nothing; that is an initial condition of knowledge; but many do not know that, and that is a condition of second-order ignorance".[47] In that sense the title of this section is a misnomer in that all reflection should be, by definition, second-order wisdom - the wisdom of not knowing.

Perhaps the most valuable aspect of this forum was the sharing of the experience of partial knowledge, multiple perspectives and acknowledged ignorance of the question we were trying to understand. This is not a position readily taken in a culture that demands expertise and 'right answers' but is part of the challenge of what we have come to call 'second-order' dialogue.

What we attempt to do here is to share our own reflections on what has come out of the forum and its relevance to the starting question "How might emerging second-order science contribute to policy development and its evolution in the future?" These thoughts are informed by and incorporate some of the feedback and conversations since the event.

The initial question itself made a number of assumptions. First, second-order science is an emerging field. The diversity of views in the forum revealed different threads where seizing one of them as the defining formulation would have clearly destroyed a multi-perspectival approach. Second we assumed that there is such a field as 'second-order' science. There were arguments that there is nothing radically new here and that characteristics of second-order are already present in many disciplines. Third, we assumed that policy making is itself undergoing change and further development in its nature. This became more evident as a diagnosis of a 'policy gap' opening up between reality on the ground and the effectiveness of governance.

The explorations of this question from a variety of perspectives and backgrounds opened up a rich discussion which had the dual nature of progressing various lines of enquiry but also raising considerable frustration in terms of clarity of shared definitions and language. This seems to us to be entirely consistent with opening up a developing field and being on a learning journey[48] which itself is a second-order endeavour. Clearly more research and dialogue is needed and improved ways of engaging with policy challenges need to be developed.

Our aim here is to draw out some of the common threads that, to a greater or lesser extent, emerged from the dialogues that might offer a platform for further discussion and research. The structural and circular nature of the field as contrasted with the linear sequential nature of linear logic and more like breaking into the circular loop and exploring the space. This is also in the spirit of von Foerster's definition of second-order cybernetics as "the study of observing systems".

In the description of the seven threads which follow, references are made to the talks given in the first part of the forum. These are to highlight aspects which struck us but are not intended to be a comprehensive review of each talk. All the contributors touched, explicitly or implicitly, on all seven attributes. Since the forum took place it an important contribution in this field has been published by Muller and Riegler.[49]

Thread 1 – Presence of the Observer

"In no way shall the observer enter into the observation"[50] is one of von Foerster's aphorisms summarising the nature of first-order science. This view generates 'objective knowledge' about the 'real world' out there. It leads to manipulation of the 'out there' and our highly technologized society. In so far as aspects of this approach have degrading effects on human beings then there are implications for policy. The presence of the observer in the observation is proposed as a fundamental condition in second-order science. In this sense all scientific knowledge is some form of intersubjective consensus amongst a community of scientists. Where those scientists are ignorant of their assumptions about knowing, they are restricted by second-order blindness to the implications of their position. However, the observer is also a decider and actor and, in that sense, imposes policy by the very nature of way he or she frames observation.

The centre piece not just the observer but the triadic system described in Müller's talk. The *observer/decider/actor* is participating in a *society* with a *language* that makes communication about the matter at hand possible.

In his talk, Cooke pointed out that the mindset and focus of interest of the 'farmer as observer' has a radical effect on the ecological results of farming practices and that restorative agriculture requires a change in the perception and involvement of the community of farmers. Page's account of coastal management also makes it clear that simply applying ecological science will not work. The evidence base is itself a component of a larger complex system embracing the nature of governance, community and the perception of what is going on by the different stakeholders. Developing a language of common understanding is essential. In the health field, Getz draws a clear picture of how the difference between the medical view of the 'person as a cloud of data points' and the 'person as a subject in search of wellbeing' lead to quite different policies and practices of health care. The former is first-order, treating the person as an object. The latter acknowledges the existential presence of the person in whatever data field they exist. However, the language of personal existence in health and wellbeing tends to get side-lined in a medicine dominated by first-order science.

An implication for policy is that placing too much emphasis on the first-order evidence base will deny the real dynamics of individual persons whose future behaviour is not reducible to statistics.

Thread 2 – Intervention and Ethics

The observer is not merely an observer. We can substitute terms like actor, decider, and intervenor. From an enactive second-order perspective, in a world that is highly structurally coupled, there can be no such thing as a totally detached observer. Any position (even that of non-observation) is an intervention. For example, the seemingly objective nature of high energy physics served by massive infrastructures like the Large Hadron Collider is the result of an intersubjective consensus between scientists and politicians to privilege that kind of research through massive investments and to make claims for that view of the world.[51] Dominant fields of science are now embedded in substantial infrastructures of shared data, shared technological facilities and shared modalities and expectations of what constitutes science. This level is referred to as zero-order science.

In such structures assumptions are being made based on values and judgements as to what is 'in' and what is 'out' of consideration. Yet these judgements are often invisible and remain unquestioned. Research becomes a methodological game played on a field where the game itself is taken as objective. However, the implications are such that each dominant infrastructure is itself an intervention in prescribing the accepted nature of science. This can be correlated with Kuhn's distinction[52] between science that is puzzle solving (within a field) and science that is paradigm shifting (disrupting and changing the field itself). This leads to a clash between socially constructed boundaries and natural boundaries with usually unintended consequences. Part of the second-order process needs to involve developing a shared language of values and ethics. Midgley[53] emphasises that the modality of second-order science is intervention rather than observation in its passive detached sense. This moves science on from simple inquiry into truth to also considering rightness, subjective understanding and improvement. First-order science is not value neutral whatever its claims to the contrary. Thus intervention implies boundary critique as an essential second-order discipline to reveal what are often limiting assumptions in bringing about change in society – again with implications for policy.

An implication for policy is that the use of 'objective evidence' is at risk of being interpreted and used as an argument for political ends without making clear the value assumptions behind its 'objectivity'. A complementary second-order discipline would seek to make clear the position assumed by the 'objectivity' of the research.

Thread 3 – Reflexivity and Reciprocity

Observation and intervention are not one-way streets. There is reciprocity between the observer and the world observed. The observer is participating and there are consequences. Making the observation may not leave the observed in a constant condition. This is well acknowledged in the uncertainty principle in quantum physics. Second-order science takes this as a condition of all observation, albeit with very different scales of registered effect. Reflexivity has implications for policy making. First-order policy interventions tend to assume a problem situation needs fixing, apply a fix, and then assume alleviation of the problem. There is no change in the nature of the system intervened in. However, intervention often creates new conditions (sometimes referred to as unintended consequences) for example by provoking new ways of gaming the system. A second-order policy would pay much more attention to this effect and as a result would have to go beyond the administrative divisions and specialised perspectives of a mechanistic approach.

The problem of reconciling politics with evidence-informed approaches was highlighted by Lähteenmäki-Smith. She points out that progressive policy making is becoming increasingly experimental. Indeed, the Finnish government has declared a principle of experimentation and deregulation thus enabling overt recognition of a reflexive contribution to change and improvement. The experimental approach with community participation is one way we ensure legitimacy of public opinion in scientific dialogue.

This kind of process is also emerging in the international field as Topping (p19) described from his experience of the Paris COP21 negotiations in 2015. Climate science is reasonably well established and agreed, but the interpretation of its significance and hence what to do about it is reflexive on the scale of almost 200 nations. In such a situation simple logic from evidence to action is not available without massive interaction to create an intersubjective agreement as to what the situation is and what can be done about it. In the field of education Leicester draws attention to the transformative nature of establishing a new order, in this case of secondary education. Whatever the scientific diagnosis of society's future needs there needs to be an operational language to enable people to connect their educational communities to the intellectual and operational means that are proposed.

A policy implication is a shift in governance from a culture of imposition to a culture of experimentation. The former requires the construction and implementation of a 'correct' policy whereas the latter recognises that effective policy is more likely to be created as shared intervention to address a problem area acknowledging that this is a learning process for all concerned and that learning may be a continuous process rather than a once and for all correct answer.

Thread 4 – Circularity and Re-entry

It is well-known in the domain of first-order systems modelling that effects can be causes (causal loops). Second-order circularity implies that the condition of the observer changes from the feedback of the observation. One interpretation of this is the idea of the observer as a learning system. A more technical version of this principle is the principle of re-entry: that any field can be applied to itself as, for example, theory of theory, method of methods, and cybernetics of cybernetics. From a second-order perspective the observer is continuously bringing forth a world and responding and learning from that world. This stance supports the view that comprehensiveness is impossible. Knowledge is not some static object 'out there' but is constantly reforming through the engagement of the knower; and the knower is changed by the encounter with knowledge.

Müller highlights a model of second–order problem formation by applying the notion of re-entry to any field of first-order science. A foundation for this way of thinking is the original work of Spencer Brown[54] and the proposition of the cybernetics of cybernetics by von Foerster.

Wahl refers to the Santiago school of cognition developed especially by Maturana and Varela[55]. This view sees a circularity between the perceiver and the world such that the perceiver brings forth a world but is also determined by what the world throws back.

An implication is that policy development needs to be more consciously a learning process rather than the imposition of answers. This could make more transparent, for example, the hidden assumptions in the use of economic models by a re-entrant study of models of models. This might make it easier to unearth the buried assumptions behind financial crises.

Thread 5 - Reflection and Perception

We are used to the practice of reflection in the sense of mentally looking over some piece of knowledge we have taken on board or generated. Second-order science takes this further and treats the self-experiencing mind as the primary conscious instrument of the science, a priori to the tools of investigation and measurement - microscopes, telescopes, computer modelling and so on. This shows up in the idea of a science of qualities drawing on the tradition parallel to Newton advocated by Goethe.[56] The science of qualities participates in the attributes of second-order science and should, in my view, embrace this approach as complementary to that arising from second-order cybernetics. An important aspect of this approach is its emphasis on the unique nature of a given human observation capable of attuning to and making sense of distinction as distinct from mathematical average.

Another aspect of the human mind that is essential for generating new knowledge is creativity. This is essential for the progress of first-order science but is often rationalised out of any account. The creative observer is removed from the novel observation in the process of 'scientific reporting'.

Wahl highlighted several of these aspects including the work of Bortoft[57] on the phenomenology of perception in relation to real and counterfeit wholes. Montuori the role of creativity and improvisation in being able to explore new territory. This creativity, in the face of complexity, needs to be collaborative but often scientists emphasise the analytical and neglect the creative.

Policy development heavily dependent on statistics will inevitably tune out individual distinctions and lead to 'one size fits all' regulation. A reflexive science of qualities will take far greater notice of individual differences and shape policy to enable greater self-organisation.

Thread 6 - Transdisciplinarity

First-order science has built its structure of knowledge through intense development of specialised disciplines which develop their own methodologies, language and ways of explaining the world. Even when disciplines interact to form cross-disciplines (such as biochemistry, astrophysics and complexity science) these tend rapidly to assume the same bounded status as other disciplines. On the other hand the world shows up in richness and complexity such that any discipline is a slice through a greater reality. In second-order science the direction is towards greater inclusiveness and the search for common cross-cutting principles. In this respect interdisciplinarity only goes so far since it is the juxtaposition of existing disciplines. Transdisciplinarity is an attempt to go under and beyond these distinctions and seek other forms of insight.

Montuori emphasised that the world shows up in too complex a way to be accommodated in disciplines and so some form of second-order approach is essential in order to engage productively with ‘wicked problems’, or aspects of the global problematique like climate change. Hämäläinen analyses the same problem by pointing out the increasing complexity gap or mismatch between the increased complexity and uncertainty of the world on the one hand and the established governance arrangements and institutions of the society on the other. The abundance of information in the internet era is not itself a solution to complexity but rather an amplifier, challenging sense making.

Government is divided into departments with responsibilities. Yet the world of complexity is highly interconnected and not reducible to linear causation. The presence of second-order methodology in policy development would take a transdisciplinary approach and ensure a much wider incorporation of knowledge and judgement from different fields.

Thread 7 – Multi-perspective Dialogic

In dealing with complex situations that do not yield to a single discipline or when treated that way give distorted results, it is valuable to take several perspectives. This principle was successfully applied in the early days of operational research. The principle is recursive in that, even within a discipline, multiple experts may bring out different aspects and enrich understanding. The practice of seeking a second opinion is well used and the same applies in this sense to peer review within a discipline. Second-order science takes this further since it assumes the reflexive and generative nature of inter-subjective consensus building. The process of dialogue around a question from a number of disciplinary or stakeholder perspectives enables a creative emergence.

Flanagan contributed a view of this, building from the idea of third phase science. The terminology of three phases rather than two orders (1st and 2nd) may seem confusing at first. My own framing of this distinction is that second and third phase science are both forms of what here is called second-order science. The distinction is that in third phase science the multi-observer dialogue is an essential procedure of the discipline. This type of emergent process is also reflected in Wahl’s account of a science of qualities.

Multiple perspectives, brought together, are important for discovering blind spots. However, information itself is not enough. Unless there is participation there will not be understanding and ownership by the different parties. Situations that seem intellectually coherent will disintegrate for value and emotional reasons that have not been worked through. A second-order dialogic process acts as stabiliser ensuring greater acceptability.

Implications for Policy Making – Weaving the Threads

These seven shared attributes of second-order science are summarised in the diagram below. In this representation the explicit presence of the observer is made the central distinction. Sharpe[58] points to the irreducible nature of the first person experience. If we accept this, then all knowledge is seen as some form of intersubjective co-ordination of our first person experiences of the world. The first person perspective is, of course, prominent in many of the social sciences. Umpleby[59] points out that in the social sciences knowledge is not just the product of an investigation but also part of what is investigated. Some approaches in the social sciences include several of the factors in the summary diagram that follows and partake of second-order perspectives. He also points out that “an overly limited conception of science (i.e. one that excludes the observer and the effects of theories on society) limits investigation and constrains how science can contribute to improvements in society.”

In Figure 15, six outer attributes may be more or less strong in a given piece of second-order work. For example, some research strongly emphasises re-entry. Other research emphasises transdisciplinarity. Yet other research makes reperception and creativity a major factor. These differences are partly to fit the method to the requirement but also partly due to the fragmentation of the field. A strong second-order science would weave these strands together to mutually reinforce one another.

Figure 15 – A seven-fold structure for a complete second-order science

In the review of the seven attributes some conjectures were made about the relevance for policy development. The essential points are summarised below as a speculative indicator of what the benefits of such an interwoven approach might be. A comprehensive second-order approach might:

1) appreciate the real dynamics of individual persons whose future behaviour is not reducible to statistics;
2) seek to make clear the position assumed by the ‘objectivity’ of the research;
3) stimulate a shift in governance from a culture of imposition to a culture of experimentation as a continuous learning process;
4) make more transparent the hidden assumptions in the use of models by a re-entrant study of models of models;
5) take far greater notice of individual differences through qualitative methods and shape policy to enable greater self-organisation;
6) take a transdisciplinary approach and ensure a much wider incorporation of knowledge and judgement from different fields;
7) adopt a second-order dialogic process, different from customary consultation, to act as stabiliser ensuring greater acceptability through participation and multiple contributions.

The simplistic application of policy can result from voting by a public that does not have the time, means, nor interest to hear multiple sides of issues before choosing. If policy development does not establish an inclusive, transparent, and coherent means of reflecting policy deliberations on complex situations, policy deliberators are at risk of losing their public legitimacy. This is a huge social risk of rejection and back-lash. Because policy developers are both the key beneficiaries of the success of second-order science and the key victims of its failure, policy developers are prime parties to advocate for this new science.

This, however, will require an introductory form of second-order science that is both readily intelligible and translatable into practice. This requires the involvement of the public, of communities of interest as well as experts and politicians. New forms of collaboration between all stakeholders are required to get the voice of all perspectives into the dialogue. Stakeholder analysis sheds light on the range of perspectives which influence or will be influenced by a specific policy deliberation, and an even representation of all perspectives will provide a mechanism for discovering the nature of the problem seeking resolution. This problem definition – and potentially additional alternative definitions of the problem -- then must be taken to a larger forum for ratification on a populace basis.

The central issue of deciding what action to take in the face of uncertainty (or contingent certainty) is a political issue, and such a decision can only be taken by reaching beyond observational science and accessing broad civic aspiration. The technology for merging matters of concern with matters of fact is an emerging science, and this aspect of second-order science does not have precedents in established observational science disciplines.

A working hypothesis to move this forward is to affirm that policy is more likely to accord with the realities it is trying to govern if it actively applies the seven attributes to the research and development of policy in an integral way – weaving the threads together.

This would generate the following guidance principles:

1. Involve those who will need to enact the policy at the start and recognise their observations of the issues in the situation of concern and recognise that for each situation a new language has to be crafted
2. Recognise ‘policy as learning’ and therefore a process of learning cycles;
3. Realise that in a situation of circular causality, ‘head-on’ sorting the situation out is likely to have significant unintended consequences;
4. Create conditions for those involved to have a safe context in which they can share observation and learning without sanctions and where ‘learning from mistakes’ is part of the process;
5. Whatever the focus of the policy area, do not restrict participation to specialists in that area alone. Place the policy making in a wider context;
6. Use processes of facilitated dialogue and similar methods to ensure that ‘all voices are heard’ and that prior persuasions do not overly restrict what is allowable and what is off limits;
7. Even where the policy has a foundation in what seems to be ‘hard’ evidence, consider the ethics of any policy position as part of its evaluation. The pressure to privilege economic criteria, for example, is a first-order stance.

Having said that, it is important to retain clarity that advocacy for a second-order approach is not intended to displace or contradict first-order science rather to enhance its possibilities and place it within a more human and value determined context.

PROPOSITIONS FOR CONTINUING EXPLORATION

> “A great transformation can be qualified as a rare societal event which corresponds to the scheme of a phase-transition from a traditional configuration to a radically new one.”
>
> Karl Müller [60]

Our original question described second-order science as emerging. This is not a quick process. Müller describes this emergence as nothing less than a Copernican revolution in science. He also estimates that as much as 70% of early attempts at the new science are now obsolete as the field develops. However, this slow evolution does not rule out the potential for sudden changes of understanding and development.

What this forum attempted to do, whilst acknowledging the considerable pioneering contributions reflected especially in the Journal *Constructivist Foundations,* was to expand the field on the hypothesis that the deeper principles of second-order thinking are not restricted to the focus on the schools of thought emerging from the second-order cybernetic field. Rather the working hypothesis is that the crisis in the relationship between science and society on a limited planet is triggering different responses which, although unlikely to be unified, are nevertheless heading towards a more universal formulation that will extend its usefulness to both scientists and those who guide or benefit from science. This is in the spirit of the capacity of second-order science to embrace a wide transdisciplinary field.

Three propositions for future work stand out:

1) Further research into second-order concepts and methodology that will support answers to the question “I wish to do second-order science. What do I do?”
2) Further investigation and synthesis of the learning around where current approaches to policy development and application are failing. This is essential to answer the question “how might second-order science create better results in governance of society?”
3) Deliberate (and funded) projects which set out with a second-order methodology to discover what the benefits and shortfalls might be. This would move towards answering our primary question in the forum : “How might emerging second-order science contribute to policy development and its evolution in the future?”

These are tough propositions for re-education after 200 years of the hierarchical specialisation and the domination in the natural sciences of reductionism and observer exclusion.

Who is making the scientific inquiry and what community of scientists do they belong to using what kind of language?

How are we educating scientists to be skilled in the seven attributes as part of developing capacity for second-order science?

How can we reconcile the tendency of politics to be driven by single issues to a politics amenable to transdisciplinary learning?

How can science better take part in the creation of the changes that its research has revealed to be necessary for human and planetary well-being?

This forum shared some diverse disciplinary perspectives, generated excellent dialogue, explored questions and questions arising from questions. Our hope is that it is a contribution to extending both the dialogue and the research agenda around second-order science and its potential for improving policy to match the nature of a complex interactive world.

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Forum in Action

Appendix - Members of the Forum

Participant	Angle of Approach	Current Role
Chris Cooke	Holistic management applied to soil regeneration; second-order methods of social transformation	3LM (land and Livestock management for Life); affiliate of the Savory Institute
Ioan Fazey	Interdisciplinary research; resilience, adaptation and transformation; participatory practice and social learning	Professor of the Social Dimensions of Environmental Change; Director, the Centre for Environmental Change and Human Resilience (CECHR), University of Dundee
Tom Flanagan	Interdisciplinary research; resilience, adaptation and transformation; participatory practice and social learning	President, Institute for 21st Century Agoras
Linn Getz	General practice; Psychiatry; occupational medicine; sustainable preventive medicine.	Processor in Behavioural Sciences in Medicine (Bio-Psycho-Social Medicine), Department of Public Health and General practice, Norwegian University of Science and Technology
Timo Hämäläinen	Futures, wellbeing, research; innovation and emergence of new economies	Leading Specialist, Strategic Research, SITRA; IFF
Anthony Hodgson	Second-order systems science and futures; anticipation and decision making; facilitating transdisciplinary collaboration; integrative thinking.	Director of Research, IFF and Decision Integrity Limited. Honorary Research Fellow University of Dundee
Kaisa Lähteenmäki-Smith	Public policy; science; technology; environmental politics	Prime Minister's Office, Finland
Graham Leicester	transformative innovation; future of education; interdisciplinary collaboration	Director, International Futures Forum (IFF)
Gerald Midgley	Systems science; boundary critique; systemic intervention for community development	Professor, University of Hull; Associate Dean, Hull University Business School
Alfonso Montuori	High potential leadership development; creativity and innovation; systems thinking and complexity;	Professor Evolutionary Strategies, Professor of Transformative Inquiry, California Institute of Integral Studies (CIIS)

	transdisciplinarity	
Karl Müller	New cybernetics; constructivist philosophy; second-order science; complexity in the social sciences	Professor, University of Ljubljana; Director, Steinbeis Transfer Centre New Cybernetics, Vienna
Stephen Olsen	Coastal and marine governance, PEMSEA – the Permanent Commission of the South Pacific; effective management of of coastal ecosystems.	SustainMetrix (John Hopkins University) Senior Advisor and Independent Consultant; Former Director of the Coastal Resources Center, University of Rhode Island.
Glenn Page	Response to rapidly changing coastal conditions; transdisciplinarity and governance of complex socio-ecological systems.	Research student at the University of Dundee; founder SustainMetrix; former Director of Conservation at the National Aquarium, Baltimore, USA
Richard Sanford	Monitoring wider environment to inform government policy development reporting to Chief Scientist.	Head of Horizon Scanning, UK Government Office for Science
Bill Sharpe	Technology foresight; innovative methods for futures work; facilitation of collaborative work	Visiting Professor, University of West England; Senior Associate, Normann Partners; IFF
Nigel Topping	Advisor to World Bank on Climate Policy and Carbon Pricing; rewiring global capitalism to create the wisdom economy	Executive Director, CDP Global Environmental Reporting System; CEO, We Mean Business;
Daniel Wahl	Design for sustainability; resilience; education for global sustainability	Independent consultant and author on sustainability and resilience; design and teaching for Gaia Education; IFF

The Forum

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Together with International Futures Forum, Sitra organized a workshop with some of the leading thinkers and policy practitioners in this emerging field in order to make sense of and synthesize the potential contributions of SOS to the future of scientific research and public policy. Drawing on the excellent synthesis of the master mind and facilitator of the workshop, Anthony Hodgson, I would reinterpret our key learnings about the SOS from the complexity perspective in the following way.

Timo Hämäläinen
SITRA
Finland

This Forum would not have been possible without the interest and support of a number of people.

Firstly we would like to thank the staff of the International Futures Forum at the Boathouse who enabled a smooth flow between the conference room, the lunch breaks and the toing and froing to the hotel as well as the excellent Forum Dinner at the Balbirnie House Hotel. The conference facilities in the Boathouse are also to be singled out as a great enabler thanks to their development by pat Heneghan, founder of the Forth Road consultancy.

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However, without committed and enthusiastic support from the delegates the event could not have held together. It felt as if we were all deposited in unknown territory with some things visible and others obscured by swirling mists. Never-the-less with a great co-operative spirit we navigated our way through the territory. An analogy might well be those early expeditions to reconnoitre the approach to Everest before it had even been climbed. It paved the way for many subsequent conquests. We all hope that our explorations will feed into the growing attention that is being given to not just second order, but third and even fourth order notions. Our heartfelt thanks to the intellectual contributions and the good will they brought to the event. They are acknowledged through the list in the Appendix.

Questions of the relationship between second-order science and policy are not yet a usual area of discourse and investigation. Without the special anticipatory interest of Timo Hämäläinen the project would not have come about. Without the support of his senior executives in the Finnish Innovation Fund, SITRA, there could not have been resources to carry this out.

Anthony Hodgson

Graham Leicester

International Futures Forum

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